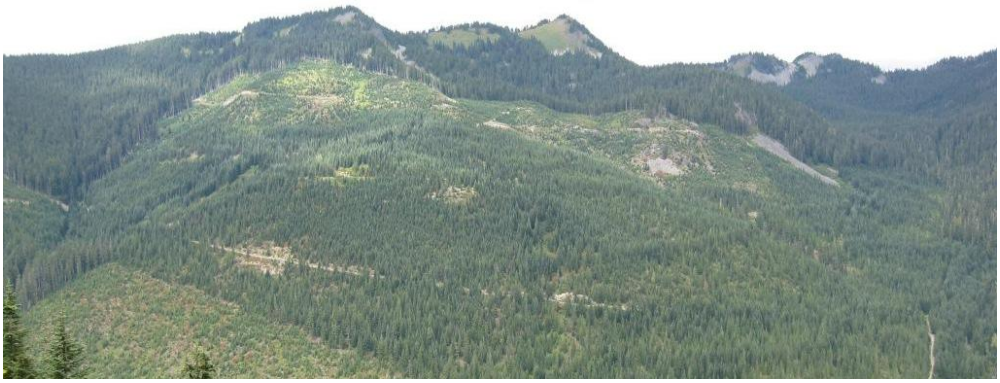
2010 Restoration Thinning Project Plan and As-Built



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1.0 Introduction and Background

Upland Restoration Thinning is the thinning of dense second-growth forests generally less than 30 years of age that have relatively low biological diversity and are in or approaching the competitive exclusion stage of forest succession. The 2010 Restoration Thinning Project Plan defines objectives and methods of the restoration thinning program, provides detailed descriptions for individual units along with supplemental documentation, special sections for planting and slash treatment, and a decision model for protection of sensitive species. Overviews from the Habitat Conservation Plan (HCP) and Restoration Thinning Candidate Pool are presented as appendices to this plan. Actual cost information as well as a record of accomplishments and lessons learned was incorporated into this plan at the end of 2010.

1.1 Project Context

The project planning area is located across three separate areas: upper Rex and Pine Creek drainages, above the North Shore Cedar, and Bear Creek/North Fork Cedar. Project area description for thinning in Rex and Pine Creek is found in the 2009 Restoration Thinning Project Plan. Project area description for North Shore Cedar units are found in the Assessment of the North Shore Cedar Area for Potential Habitat Restoration Treatments. The project area for Bear Creek/North Fork Cedar extends from an unnamed tributary of Bear Creek on the north side of North Fork Cedar to the watershed boundary at Twilight Lake. Additional restoration thinning on the south side of North Fork Cedar and between the unnamed tributary and mainstem Cedar River is planned for 2011 (Unit 50.2). In 2003 and 2004, significant portions of the second-growth within the North Fork Cedar were thinned at 15'x15' and 16'x16' spacing, with a smaller amount at 13'x13' spacing. This 2003 and 2004 thinning did not include skips of unthinned trees or tree-free gaps. This earlier thinning focused on the stands with larger tree sizes and higher tree densities. The result of this thinning effort is a uniform forest surrounded by old-growth or unthinned second-growth. The 2010 project will thin or place into reserve, following candidate selection criteria, the remaining eligible areas north of the North Fork Cedar and portions of Bear Creek in an effort to complement habitat structure types that are already present in these areas (Figure 1).

Significant old-growth forest and special habitat areas (e.g., meadows, talus slopes, and lakes) are present throughout North Fork Cedar and Bear Creek sub-basins. The Landscape Synthesis Framework identified this area as a high Synergy Site. Following the restoration thinning candidate pool development process, the restoration thinning units in this area received a high priority ranking (Ranks of: 10, 16, 29, 40, 50, and 89 out of 137 total stands). Marbled murrelets are known to occupy the old-growth forest immediately downstream of the confluence of North and South Fork Cedar River. Though northern spotted owls have not been detected nesting in this area in the last couple of decades, the older forests in this area could possibly support breeding pairs. Numerous talus slopes are scattered throughout the planning area, which may be important to unique wildlife species including amphibians. Elk also frequently utilize this area as summer range. Previously, slash treatment near Twilight Lake focused on

improving access to big huckleberry resources for tribal gatherers; significant huckleberry resources in this area remain unthinned prior to implementation of this 2010 plan. Pre-treatment data summaries are located in Appendix A.

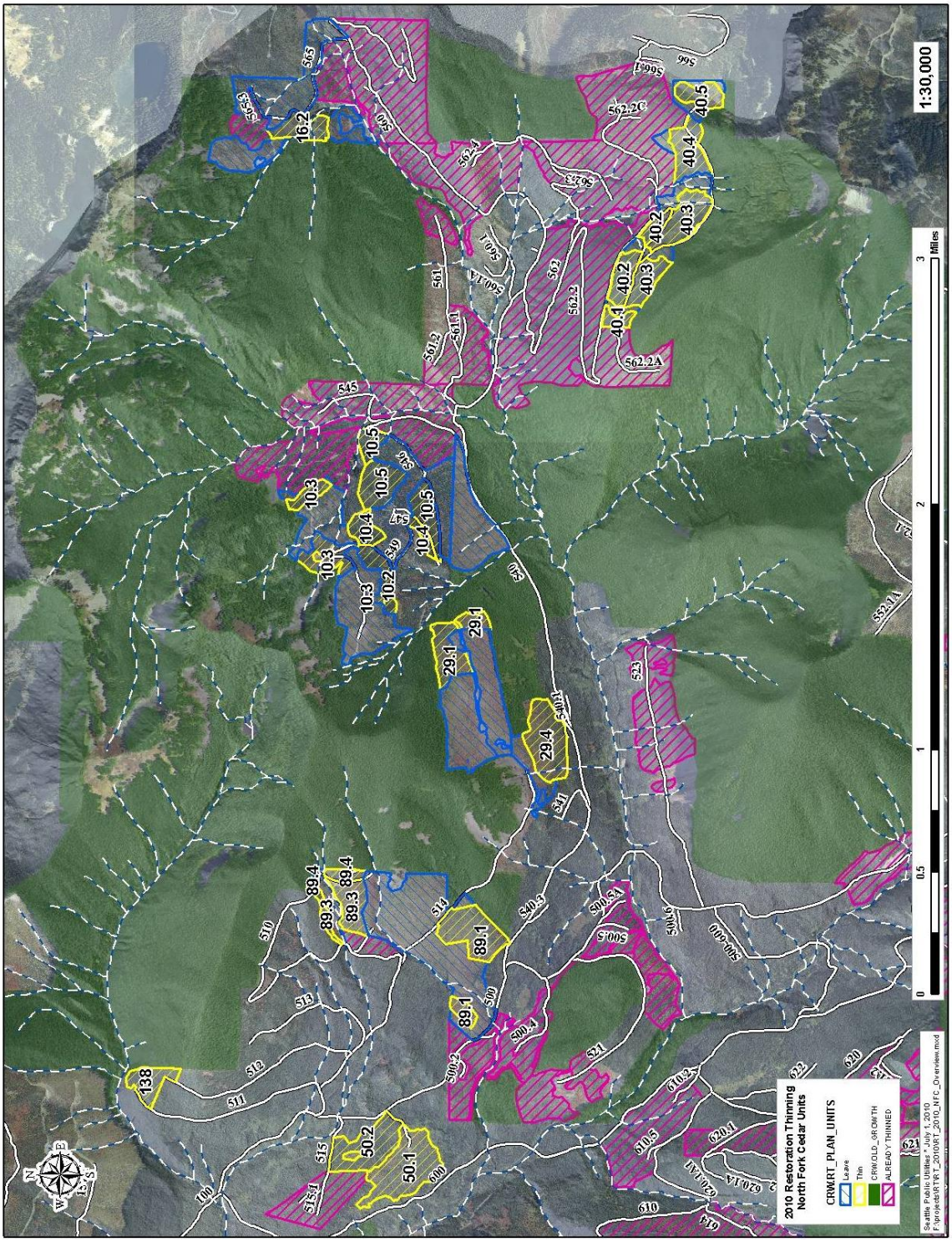


Figure 1. Overview of North Fork Cedar 2010 Restoration Thinning Project area.

2.0 Objectives and Methods

The overarching goal of restoration thinning is to accelerate the development of complex habitat in the near-term and late-successional and old-growth forest conditions in the long-term. Objectives of restoration thinning include:

- Reduce competition among trees
- Increase light penetration
- Stimulate tree growth
- Increase tree and understory plant species diversity
- Reduce long-term fire hazard
- Increase resilience to catastrophic windthrow, insect, or disease outbreak
- Accelerate forest development beyond the competitive exclusion stage towards a more biologically diverse stage, and/or
- Extend the forest development stand initiation stage such that diverse species become established and diverse stand structures develop

2.1 Additional Objectives and Methods for 2010

The prescriptions for 2010 restoration thinning treatments continue to focus on achieving the ecological objectives listed above. Additional ecological objectives considered in 2010, including methods used to achieve those objectives are to:

- Provide development pathways for variable forest stand structures
    - Variable residual tree densities and tree sizes; stand scale reserves; numerous skips and gaps of varied sizes; alternating stream skips and linear contour skips

- Increase connectivity and structural variability of riparian areas; minimize sediment from entering streams
    - Alternating stream skips; retain higher tree densities above the inner gorge buffers

- Create varied stand structures adjacent to old-growth forests and special habitats
    - Alternate dense and sparse thinning densities next to old growth; leave unthinned reserve areas adjacent to old growth; incorporate special habitats or key landscape features as skips or create variable treatments around special habitats

- Maintain cultural resources
    - Inform restoration thinning crews of cultural resource protection protocol; pull slash away from cultural resource identified trails if located; monitor work with a sensitivity to cultural resources

2.2 Landscape Perspective

Each unit can be characterized by its unique features and how it relates to other features on the landscape. The North Fork Cedar, for example, contains many unique features such as lakes, talus slopes, rock outcroppings, and shrub openings, as well as stands of old-growth forests adjacent to and within the landscape planning area. Three key landscape criteria shaped the thinking behind individual thinning prescriptions including decisions to place areas in a Reserve:

- Individual unit objectives and unique features, i.e. What special characteristics does a particular unit have when compared to other units and how should the unit objectives be tailored to protect, enhance, and promote those features?

- The location and characteristics of old-growth forests and special habitats relative to the thinning units, i.e. What locations and characteristics of nearby old growth and special habitats are unique that we should consider them in the prescriptions?

- The proximity and location to previously thinned stands, i.e. What should be done differently now considering the prescriptions and ecological response of nearby previously thinned stands?

3.0 Costs, Area Treated, and Compliance

For 2010 total area treated was 575 acres at a cost of $129,201 for an average cost per acre of $225 (Table 1). Cost per acre for thinning range from $93/ac. to $437/ac. All work was paid at an hourly rate that was bid prior to the start of work. Since the cost for each unit represents the actual amount of work required to complete the prescription, the hourly rate is a more accurate representation of cost than previous work using a per acre bid. The most important factors in cost/acre remain, in order of significance, initial stand density, residual stand density, and tree size.

Calculations of quality percentage during compliance were changed in 2010 to encourage a heterogeneous stand structure. Previously, the number of deficient and excess trees was summed to create the total number of error trees. For instance, if one plot was two trees in excess and one plot two trees deficient the contractor was penalized for four trees even though the overall density was on target. In 2010, quality percentage was calculated by the difference between the number of deficient and excess trees, i.e., two trees in excess and two trees deficient creates zero penalties. This method will reinforce the desire for increased diversity over homogeneity. For more detailed descriptions on compliance see the Restoration Thinning Compliance Protocol located in Appendix B.

Table 1. Costs and acres by unit for 2010 Restoration Thinning.

Unit	Acres	Total Cost	Cost/acre	Vendor
10.2	12	$1,637.71	$136.48	Ramon Coronel
10.3	18	$2,293.57	$127.42	Ramon Coronel
10.4	11	$1,024.74	$93.16	Ramon Coronel
10.5	35	$4,429.16	$126.55	Ramon Coronel
14.2	10	$1,697.96	$169.80	Ramirez Reforestation
14.3	4	$738.61	$169.80	Ramirez Reforestation
16.2	10	$1,027.76	$102.78	Ramon Coronel
29.1	21	$1,013.75	* $48.27	Ramon Coronel
29.4	28	$2,850.33	$101.80	Ramon Coronel
40.1	4	$1,541.40	$385.35	Ramon Coronel
40.2	17	$4,609.09	$271.12	Ramon Coronel
40.3	32	$12,299.24	$384.35	Ramon Coronel
40.4	17	$4,078.59	$239.92	Ramon Coronel
40.5	11	$3,064.24	$278.57	Ramon Coronel
50.1	36	$5,518.14	$153.28	Ramon Coronel
54.1	47	$14,977.88	$318.68	Sierra Reforestation
54.2	38	$11,822.59	$311.12	Zaldivar's Forestry Corp.
54.3	24	$7,607.43	$316.98	Sierra Reforestation
54.4	11	$5,611.77	$510.16	Zaldivar's Forestry Corp.
54.4	59	$18,031.92	$305.63	Ramon Coronel
54.6	12	$2,393.71	$199.48	Ramon Coronel
71	17	$3,788.59	$222.86	Sierra Reforestation
89.1	30	$3,137.78	$104.59	Ramon Coronel
89.3	19	$1,705.30	$89.75	Ramon Coronel
89.4	5	$1,747.63	$349.53	Ramon Coronel
90.2	5	$848.98	$169.80	Ramirez Reforestation
90.3	13	$2,275.27	$169.80	Ramirez Reforestation
138	17	$7,427.84	$436.93	Ramon Coronel
Total	**575**	**$129,201.00**	**$224.80**	

* Gaps only, no thinning in matrix between gaps

4.0 Unit Summaries

This section provides the following information specific to each unit:

- Unit history and context
- Stand descriptions and data summaries
- Unit specific objectives, prescriptions and post-treatment descriptions

Detailed objectives, prescriptions and post-treatment descriptions are provided for each subunit.

4.1 Unit 10 (76 acres)

Unit 10 encompasses 245 total acres, of which 89 acres will be thinned. The remaining unthinned acres are at or below desired tree densities. Unit 10 is located in Tinkham Creek, a tributary to North Fork Cedar River. The lowest portion of the unit (Unit 10.1) was clearcut harvested in 1991, the middle portion in 1957, and the upper portion (Unit 10.3) was clearcut harvested in 1981. Pretreatment conditions were captured through sample plots in portions of the unit and site visits during prescription development and layout. Plot data is therefore available for some subunits and not others.

Current species composition on the lower slopes is dominated by Douglas-fir. Above 3000' elevation Pacific silver fir increases in proportion quickly becoming the majority species accompanied by western red cedar and western hemlock. At higher elevations in Unit 10.3 mountain hemlock is present. Tree densities vary from sparsely spaced trees growing with open bear grass/huckleberry to widely spaced trees with thick shrub understory to densely spaced trees exceeding 2000 trees per acre. In many locations throughout Unit 10 current tree densities appear appropriate for development of complex forest structures with a high variability of inter-tree and inter-patch spacing. For these areas no thinning treatment is recommended.

Table 2. Unit 10 pretreatment data summary

		average TPA				range TPA			
Unit	n	total	ABAM	THPL	TSHE	total	ABAM	THPL	TSHE
10.2	3	3,083	3,000	83		1,250-5,500	1,000-5,500	0-250	
10.4	1	750	750			750	750		
10.5	6	2,100	2,100		42	0-3,250	0-3,250		0-250

Note: Units 10.4 contains 1 plot; 10.3 has no pre-treatment data available

Objectives specific to Unit 10

- Preserve and enhance minority species
- Maintain existing horizontal inter-tree and inter-patch spatial variability
- Increase species diversity and tree densities in areas with low tree densities

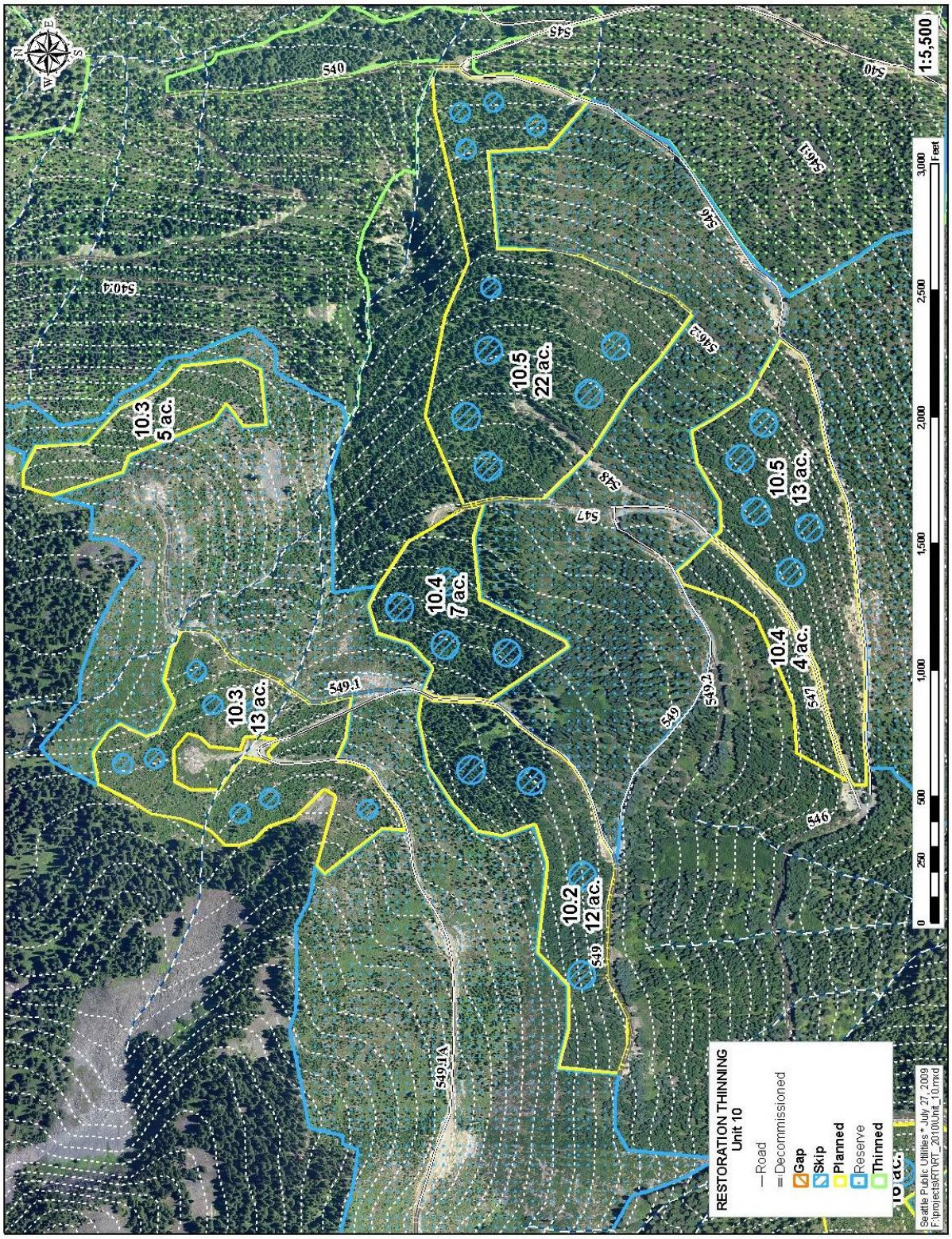


Figure 2. Unit 10.

Unit Summary

Unit 10.2 – The largest trees in Unit 10 are located in Unit 10.2. Spacing is both dense clumps and widely spaced trees with openings. Silver fir dominates with western hemlock, western red cedar and Douglas-fir in small numbers. The unit is bordered at the bottom (south) by large, widely spaced trees that originated at the same time as this unit. To the north and above, the forest is younger and both dense and sparsely treed. In order to maintain the patchy tree spacing a maximum cut limit of 9" dbh was selected in conjunction with a 15'x15' spacing including several large skips. Only silver fir will be cut thereby increasing the proportion of minor species.

Post-Treatment – A total of eight 1/50th ac. plots were installed: four measure and four tally plots. Compliance measured in Unit 10.2 was 100% based on the quality calculation. Silver fir maintained dominance with noble fir included in the compliance data. No information about other minor species is available but we assume they increased in proportion to silver fir. The average tree density is 200 tpa with three of four plots at 100 tpa and one plot at 400 tpa; indicating the objective of maintaining heterogeneous horizontal structure was achieved which is reinforced from visual inspection. Of all measured trees 69% are greater than 9"dbh indicating that the dbh cut limit was effective in determining leave tree selection.

10.3 – Younger forest originating in 1991 is spread across the top of Unit 10. Much of this dense forest is surrounded by sparsely treed areas that are still in the process of regenerating. Old-growth forest interspersed with openings and talus slopes border much of the northern edge. Silver fir dominates both the thinning units and the regenerating trees in the leave units. A maximum diameter cut limit of 5" dbh was selected to increase tree densities above what would result from a 15'x15' spacing and increase horizontal variability. The proportion of minority species will be increased by cutting only silver fir and planting additional underrepresented species in limited quantities where needed.

Post-Treatment – A total of nine 1/50th ac. plots were installed: six measure and three tally plots. Compliance measured in Unit 10.3 was 100% based on the quality calculation. Silver fir maintained dominance with mountain hemlock represented in the compliance data. No information about other minor species is available. Residual average tree density is 233 tpa. Only 15% of measured trees are greater than 5.5" indicating that diameter limits contributed little to tree retention. No planting was carried out but options do exist in understocked Reserves. The small two acre portion below the 549.1a road, even though planned, was not thinned in order to increase work efficiencies in small units.

10.4 – Surrounding Unit 10.4 is a young, sparsely treed area to the north, dense and tall forest to the east, similar species composition and variability in tree spacing but lower tree densities and larger trees to the south, and similar dense forest that will be thinned to the west. In order to provide contrasting variability to neighboring areas, a wide spacing of 18'x18' is paired with a maximum diameter limit of 5" dbh. The resulting structure will be both tight and widely spaced trees. Cutting of

silver fir around Douglas-fir and western white pine will increase the proportion of these minor species in addition to maintaining and enhancing growth of these shade-intolerant species.

Post-Treatment – A total of five 1/50th ac. plots were installed: three compliance and two tally plots. Compliance measured in Unit 10.4 was 95% based on the quality calculation. Only silver fir was found on the compliance plots although noble fir and western red cedar are present. Over 85% of the residual trees were greater than 5" dbh with a residual tree density of 350 tpa. The post-thinning horizontal variability is notable in this unit for exhibiting a high level of tree-scale aggregation. The diameter cut limit worked extremely well to achieve objectives even though tree numbers are on the higher end of desirable density.

10.5 – Similar to Unit 10.4 but having smaller trees, Unit 10.5 is the largest thinning block in Unit 10. In order to contrast to the sparsely treed areas surrounding much of the unit, a narrow spacing of 14'x14' will be paired with a maximum cut limit of 4" dbh. The resulting structure will be more uniform than much of Unit 10, especially of that to the south. Cutting of silver fir around Douglas-fir and western white pine will increase the proportion of these minor species in addition to maintaining and enhancing growth of these shade-intolerant species.

Post-Treatment – A total of nineteen 1/50th ac. plots were installed: ten measure and nine tally plots. Compliance measured in this unit was 97% based on the quality calculation. Out of a total residual density of 375 tpa, silver fir has 295 tpa with the remaining Douglas-fir (50 tpa), mountain hemlock (20 tpa), and western red cedar (10 tpa). Given the lack of pre-thinning data for this unit it is assumed that minority species increased in proportion but no quantitative value can be assigned. Of residual trees, 22% are minor species outside of the thinning pool and 80% are greater than 4"; only 8% are silver fir less than 4" dbh and were subject to spacing components of the prescriptions.

4.2 Unit 14 (14 acres)

Unit 14 is comprised mostly of uniform Douglas-fir with western hemlock at similar heights as well as significantly shorter. Unit 14 was pre-commercially thinned in 1995 to 12'x12'. An adjacent area uphill was thinned in 2007 to 15'x15' spacing with no skips or gaps. Old growth surrounds Unit 14 to the east and north with older second growth below to the south. Talus slopes bisect Unit 14.3 and border to the west.

Objectives specific to Unit 14

- Maximize tree growth of select trees
- Increase clumpy distribution
- Maintain and enhance species diversity

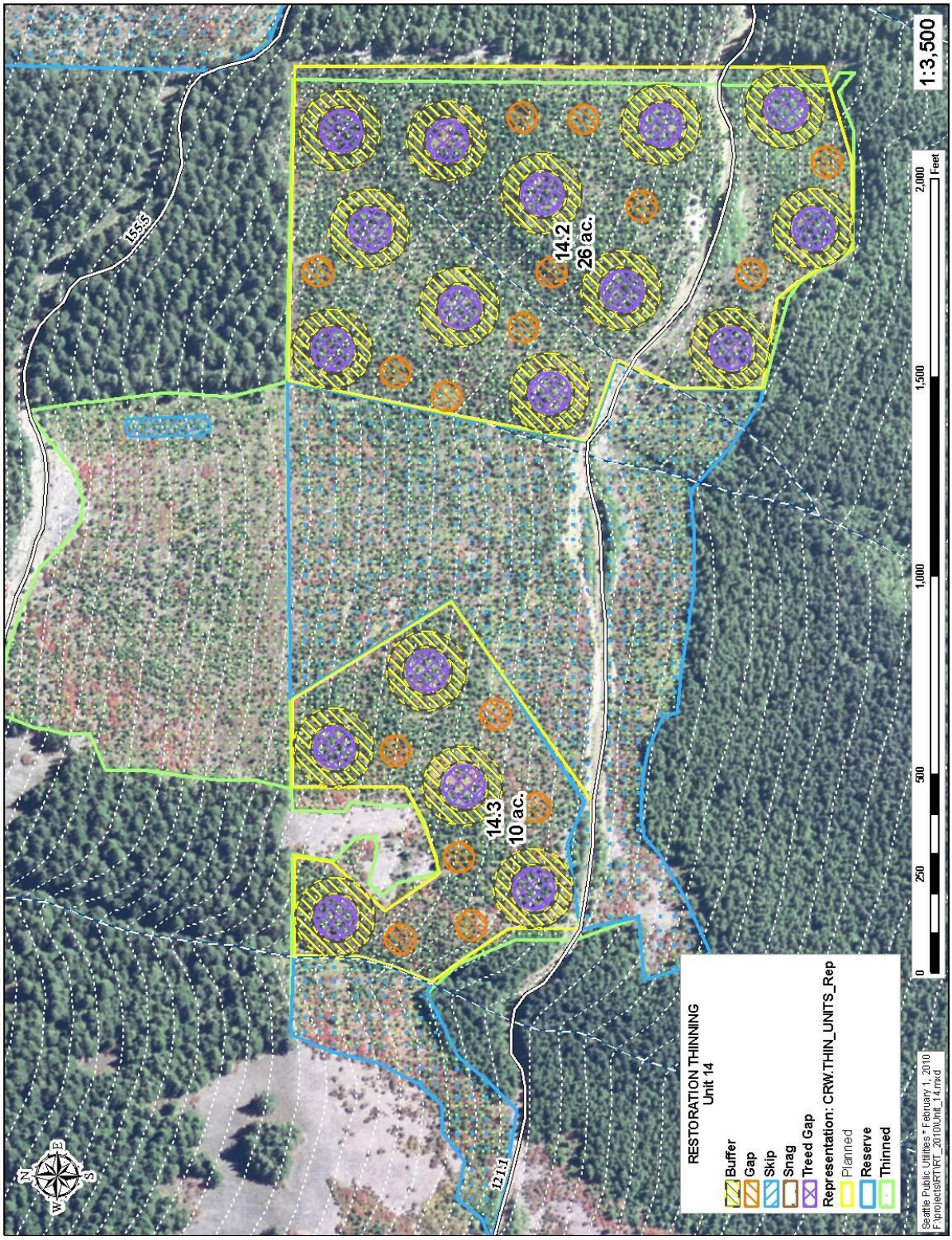


Figure 3. Unit 14.

Unit Summary

Units 14.2 and 14.3 – Prescriptions for 14.2 and 14.3 are identical with small differences in tree sizes and densities within the stands. In order to increase the heterogeneity of inter-tree spacing a series of gaps and treed gaps with 50' wide 16'x16' spacing buffers will be utilized. No remaining trees will be cut in the matrix. Western white pine, western red cedar, noble fir and hardwoods will be retained throughout the units. Matrix thinning throughout the stand would lower stand densities to that of adjoining stands and increase the homogeneity of tree spacing therefore it is not being done. Planting of underrepresented species in gaps will follow thinning operations.

Post-Treatment – No post-treatment compliance data was taken although inspection was accomplished by visual assessment of pass/fail. The objectives of increasing heterogeneity at the tree scale were achieved by the increased number of small openings and widely spaced edge trees. The planting of underrepresented species (western white pine and noble fir) in gaps increased species diversity. Layout of the two different gap types was very time intensive requiring significant staff time to flag boundaries in support of the thinning crew. The outcome created from a gap and buffer of widely spaced trees was very favorable and should be repeated.

4.3 Unit 16 (10 acres)

The focus for Unit 16 has been on encouraging growth and access to huckleberries beginning with restoration thinning and a slash yarding in 2003. Many unthinned areas have excellent huckleberry resources, e.g., Unit 16.2 and south of the 565.3 road. Tree densities and tree sizes south of the 565.3 road are currently providing excellent huckleberry growth but in the near future shading will decrease production. Unit 16.2 also contains big huckleberry and will be thinned to optimize production with slash treated to facilitate access. The remainder of Unit 16 will not be thinned due to tree densities at or below levels desired levels. Small areas of dense stands are generally surrounded by low densities and are retained to provide variability.

Table 3. Unit 16 pretreatment data summary

		average TPA				range TPA			
Unit	n	total	ABAM	TSME	TSHE	total	ABAM	TSME	TSHE
16.2	3	1,667	1,500	83	83	1,000-2,750	1,000-2,500	0-250	0-250

Objectives specific to Unit 16

- Enhance proportion of minority species
- Decrease densities to improve growth of remaining trees
- Where present, increase the growth of big huckleberry and picking opportunities for tribal members

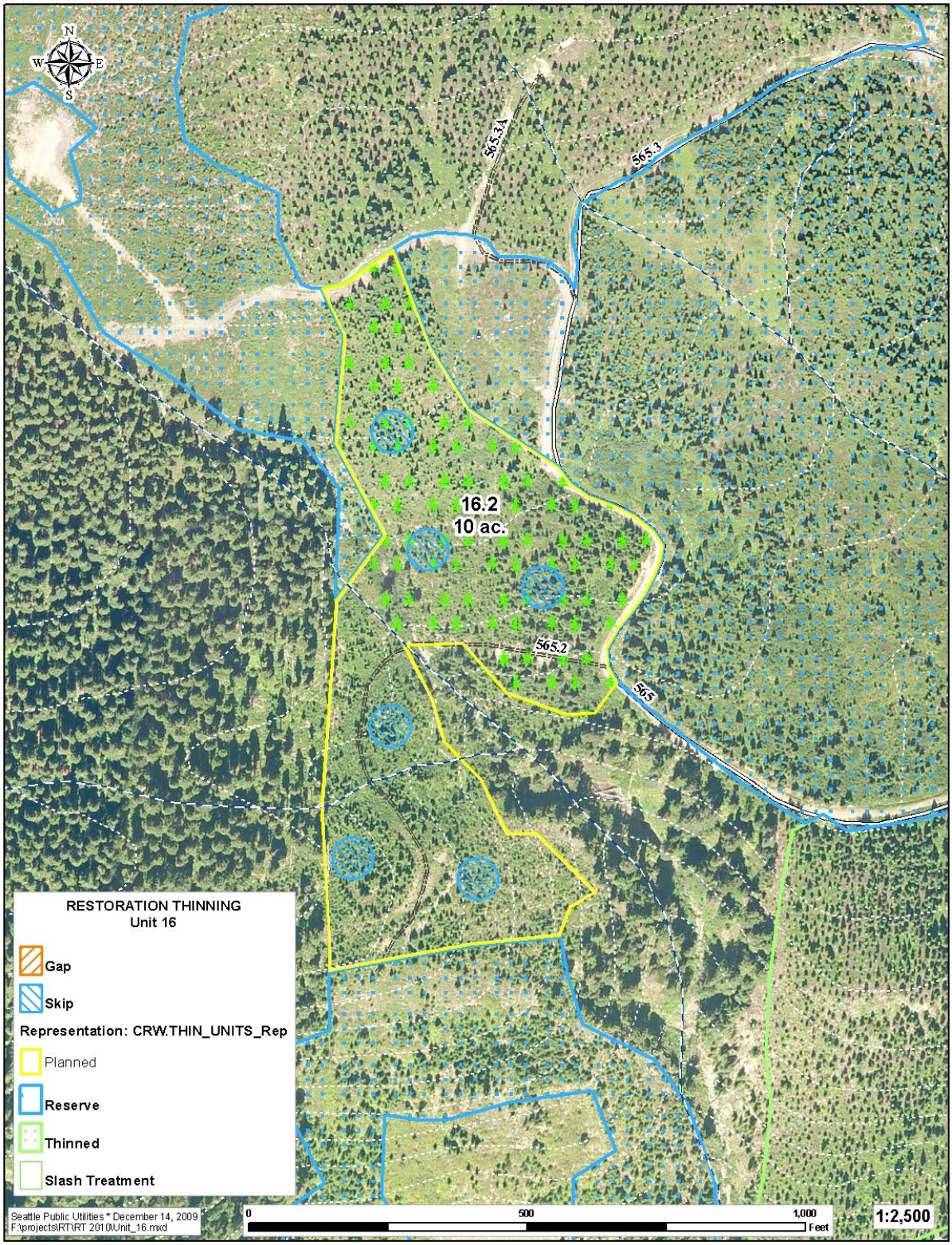


Figure 4. Unit 16.

Unit Summary

Unit 16.2 – This unit contains both dense and open stands dominated by Pacific silver fir accompanied by mountain and western hemlock. Tree size is generally small with most trees shorter than 15' in height. Given the open nature and small trees, a narrow spacing of 14'x14' with a diameter cut limit of 5" dbh will be used. This is narrower than that implemented for huckleberries in Rex Basin (e.g., 16'x16' spacing in Units 7.1 and 7.7). Cutting of silver fir around Douglas-fir and western white pine will increase the proportion of these minor species in addition to maintaining and enhancing growth of these shade-intolerant species. Slash will be treated by lopping and piling in the portion between the 565 road and the large creek that bisects the unit (7 acres).

Post-Treatment – A total of twelve 1/50th ac. plots were installed: six compliance and six tally plots. Compliance measured in Unit 16.2 was 100% based on the quality calculation. On compliance plots silver fir is the most prevalent species (200 tpa) followed by western and mountain hemlock (59 tpa), red alder (27 tpa), Douglas-fir (14 tpa) and western red cedar (5 tpa). Of residual trees, 30% are silver fir below 5" dbh indicating that the diameter limit was effective in tree selection but the spacing component also had an impact in tree retention. The spacing component was important in preventing too much open canopy for big huckleberries. Initial assessments indicate the objective of providing approximately 25% cover was achieved. Slash piling was very effective in increasing access although the density of piles is high where tree density was high limiting space for understory growth. Tree stumps should be cut lower for safety of gatherers.

4.4 Unit 29 (49 acres)

Unit 29 is composed of three different parts that were harvested at different times (1981-1985) resulting in stands of varying tree densities. Tree establishment following harvest was very poor in much of Unit 29 at higher elevations, although certain areas are dense. Huckleberry, vine maple and bear grass are the predominate vegetation throughout the sparsely treed areas. Elevation ranges from 2,700' to 4,000' and affects species composition. Douglas-fir dominates the lower section of 29.4 but a transition to silver fir dominance is nearly complete at the top (3,200' el.). Silver fir is the major species in Unit 29.1 with a small amount of Douglas-fir, western hemlock and noble fir. Portions of Unit 29 where tree densities are lower than desired will receive no thinning. Planting of underrepresented species will concentrate on stands to the west of Unit 29.1 around the 546 road.

Table 4. Unit 29 pretreatment data summary

		average TPA					range TPA					dbh	height
Unit	n	total	ABAM	PSME	TSHE	ABPR	total	ABAM	PSME	TSHE	ABPR	avg	avg
29.1	5	2,400	1,100	200	375	200	500-6,000	0-4,000	0-1,000	0-1,000	0-500	0.8	7
29.4	5	1400	150	1000	250	-	250-3,000	0-500	250-2,500	0-750	-	1.4	6

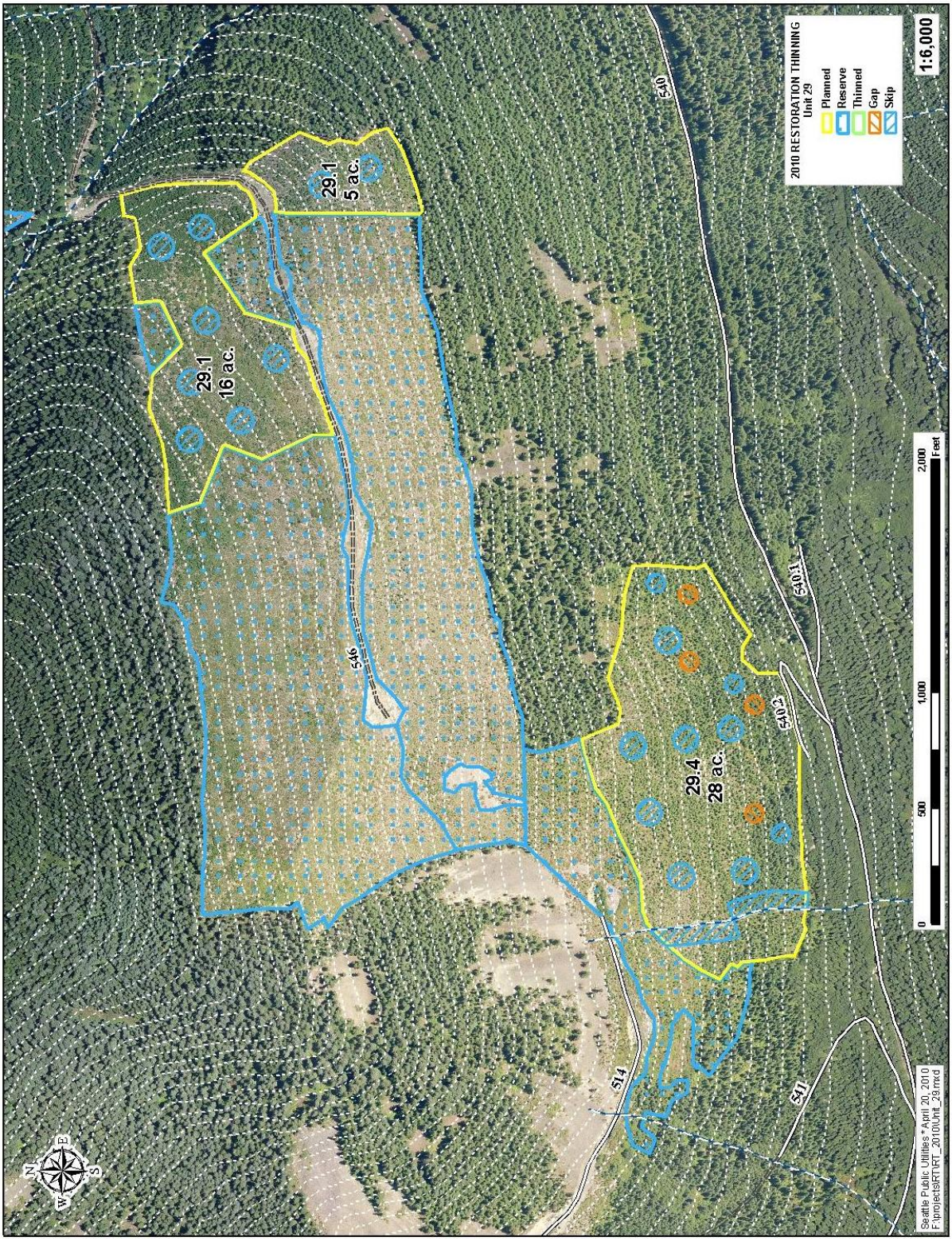


Figure 5. Unit 29.

Objectives specific to Unit 29

- Increase tree densities by planting where needed and enhance minority species
- Maintain gap and stand patchiness
- Increase proportion of minority species
- Protect slope stability of inner gorge

Unit Summary

Unit 29.1 – Tree densities in 29.1 are significantly higher than stands to the west. Pacific silver fir as the dominant species will be the only species cut in this unit. The unit is surrounded on two sides by old growth. Stand density and structure varies significantly within the unit with the northeast corner having the highest density. A patchy structure at lower densities comprises the remainder of 29.1. In order to maintain the patchy structure, 30' dia. gaps spaced 60' apart will be installed throughout the unit (Figure 6). Larger 1/5th acre skips will contrast with the gaps. It is envisioned and designed so that many of the gaps will fall in natural openings. No other thinning will take place.

Post-Treatment – No post-treatment compliance data was taken although inspection was accomplished by visual assessment of pass/fail based on the number and size of gaps. The objective of increasing heterogeneity at the tree scale was achieved by the increased number of small openings within areas that were either densely spaced or very open. In some open areas less than five trees were cut in a gap. In dense patches gaps could have been larger due to mountain hemlock left uncut in the gap thereby reducing its effectiveness. Layout time was significantly reduced as the contractor learned they could space the gaps out without flagging before.

29.4 – While tree densities in Unit 29.4 are relatively low compared to other stands in the basin, there are still benefits to be gained from thinning. Site class is III and IV near the bottom and IV/V at the top. With high proportions of Douglas-fir the objectives are to increase the growth of Douglas-fir and also increase the proportion of minor species by thinning only Douglas-fir. Between-tree variability will be accomplished through a diameter cut limit and ignoring minor species in the spacing of Douglas-fir. Skips and gaps of various sizes, along with Reserves of lower density areas, will contribute to within stand variability.

Post-Treatment – A total of fourteen 1/50th ac. plots were installed: seven measure and seven tally plots. Compliance measured in Unit 29.4 was 97.5% based on the quality calculation. The residual density of Douglas-fir (179 tpa) matches the prescription target of 170 tpa and is significantly lower than pre-treatment density of 1,000 tpa (n=5). Only one Douglas-fir across all plots was greater than the maximum diameter cut limit of 8" dbh. The overall residual density of 300 tpa is higher than desired but many of the minor species are aggregated together leaving more space for Douglas-fir.

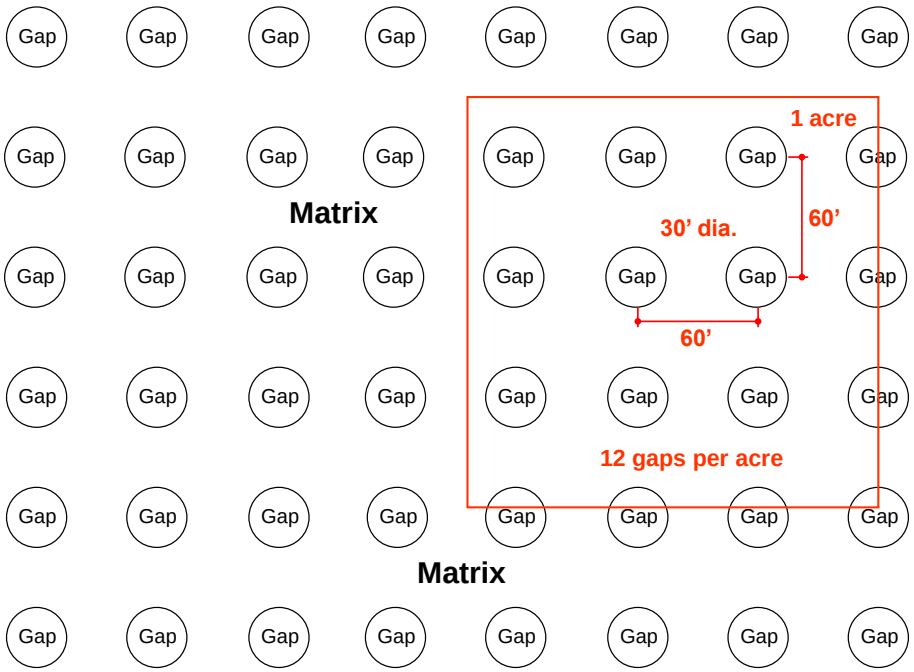


Figure 6. Treatment diagram for Unit 29.1.

4.5 Unit 40 (81 acres)

Unit 40 is the densest unit in the North Fork Cedar. Harvest dates range from 1973 and 1976 in the western half to 1983 and 1985 in the eastern portion. The southern border uphill is old growth while the northern downhill boundary was previously thinned in 2003 to either 12', 13', or 15' spacing. To the east is U.S. Forest Service property harvested in 1994 and unthinned. Several steep drainages with significant inner gorges cross the unit. Tree sizes differ within Unit 40 with the smallest on the eastern end and the largest at the bottom of the unit in the western half.

Table 5. Unit 40 pretreatment data summary

		average TPA				range TPA			
Unit	n	total	ABAM	TSME	ABPR	total	ABAM	TSME	ABPR
40	4	11,375	10,250	2,000	500	4,500-14,500	4,500-14,500	0-2,500	0-500

Objectives specific to Unit 40

- Maintain tree growth on select trees and reduce dominance of silver fir
- Increase variability at the patch, stand, and landscape scales
- Maintain and increase habitat connectivity between upslope primary forests, and downslope forests
- Protect bank stability along streams
- Decrease visual impact of thinning on the landscape

Unit Summary

Unit 40.1 – Unit 40.1 borders the previous 2003 thinning which creates a linear landscape feature that is visible from many locations, including to the public from the Pacific Crest Trail. A Leave area borders Unit 40.1 to the east. A prescription of 12'x12' spacing with skips will decrease the contrast between thinned and unthinned stands. Non-linear boundaries will further decrease the visual impact.

Post-Treatment – A total of five 1/50th ac. plots were installed, all measure plots. Compliance measured in Unit 40.1 was 98% based on the quality calculation. Total residual tree density is 440 tpa with nearly equal numbers of silver fir (140 tpa), western hemlock (170 tpa), and mountain hemlock (120 tpa) with one record of western red cedar (10 tpa). The lack of pre-treatment data on this unit would have shown the higher than expected numbers of hemlock. Prescriptions could have been drafted that further reduced the presence of silver fir and overall densities while still meeting the objectives. Given the high residual density (approximately 10'x10' spacing) the objective of decreasing visual impact of thinning units was accomplished.

40.2 – Unit 40.2 contains the tallest trees, lowest elevation and presumably highest site for all of Unit 40. The widest spacing at 16'x16' was chosen as a contrast with previous thinning below the road and Unit 40.3 above the road, as well as to allow the larger trees to take advantage of more growing space.

Post-Treatment – A total of eight 1/50th ac. plots were installed: four measure and four tally plots. Compliance measured in Unit 40.2 was 100% based on the quality calculation but excluded a five acre portion in order to increase compliance efficiencies. Target residual densities for silver fir were nearly met (156 tpa) but the inclusion of mountain hemlock (44 tpa), western hemlock (13 tpa), and Douglas-fir (6 tpa) increased the total to 219 tpa. Pre-treatment stand data would have assisted in assigning a wider spacing to silver fir thereby increasing the likelihood of achieving unit objectives.

40.3 – Bordering primary forest to the south (uphill), tree sizes decrease with rising elevation, although differences are not great. To increase variability between stands (i.e., Unit 40.2) a narrow spacing of 13'x13' was chosen. A maximum diameter cut limit will be used to prevent thinning of the largest trees.

Post-Treatment – A total of sixteen 1/50th ac. plots were installed: eight measure and eight tally plots. Compliance measured in Unit 40.3 was 97% based on the quality calculation. The contractor thinned across the western road boundary into a Reserve area. To compensate a new Reserve was laid out below the old-growth between the 20 acre unit to the east and the 12 acre unit to the west. Total residual density is 363 tpa comprised of silver fir (200 tpa), mountain hemlock (138 tpa), noble fir (21 tpa), and Douglas-fir (4 tpa). Less than 5% of residual trees are silver fir above the diameter limit of 4" dbh. Again, pre-treatment stand data would have assisted in

assigning a wider spacing to silver fir thereby increasing the likelihood of decreasing silver fir dominance.

40.4 – Tree sizes vary considerably throughout Unit 40.4. To increase the variability within the stand a maximum diameter cut limit of 4" will be used as the primary means for thinning selection. In areas of larger tree sizes, more trees will be retained. A maximum spacing of 16'x16' will entail that sufficient trees will remain in areas of low tree size where the diameter limit does not apply.

Post-Treatment – A total of ten 1/50th ac. plots were installed: six measure and four tally plots. Compliance measured in Unit 40.4 was 94% based on the quality calculation. Residual silver fir density of 167 tpa was on target for a 16'x16 spacing even though 40% of those were greater than the 4" diameter limit. The inclusion of mountain hemlock (167 tpa) created a higher than desired total of 333 tpa. Pre-treatment stand data would have assisted in designing an alternative prescription thereby increasing the likelihood of decreasing silver fir dominance and overall stand density.

40.5 – Bordering U.S. Forest Service property to the east, Unit 40.5 is the shortest in height and least developed of the units. In many locations, tree heights average less than 8'. A narrow spacing of 13'x13' will allow for continued tree growth while also accounting for any mortality that occurs over time.

Post-Treatment – A total of ten 1/50th ac. plots were installed: five measure and five tally plots. Compliance measured in Unit 40.5 was 96% based on the quality calculation. The Unit was thinned to 220 tpa consisting of silver fir (194 tpa) and mountain hemlock (25 tpa) with all measured trees below the maximum cut diameter of 4" dbh. Given the dominance of silver fir the prescriptions achieved the objectives of maintaining tree growth and reducing silver fir dominance however patch scale variability is lacking within the unit. Skip and gap layout is reversed from maps with more skips and fewer gaps than intended.

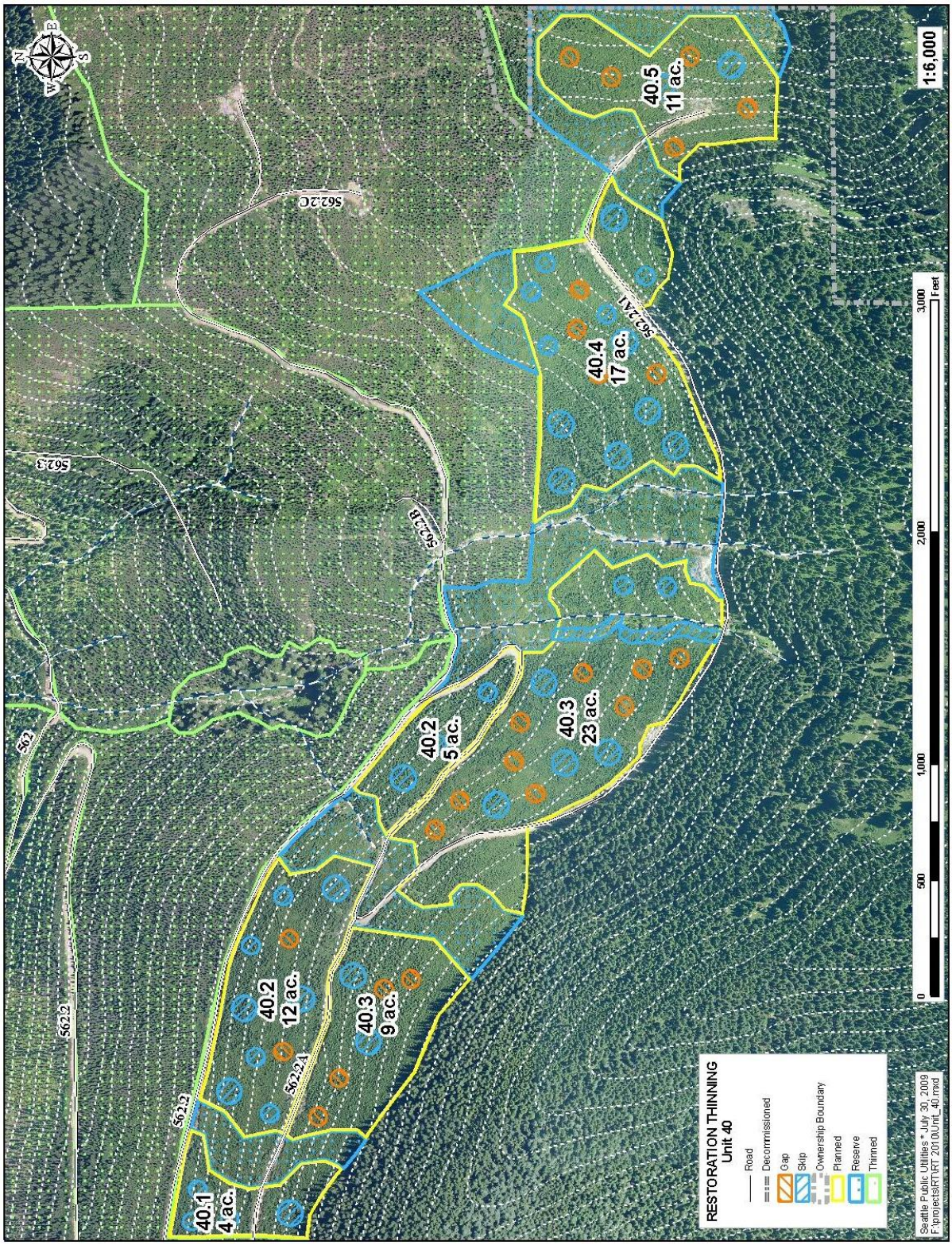


Figure 7. Unit 40.

4.6 Unit 50 (36 acres)

Unit 50.1 is the highest quality site for all 2010 restoration thinning sites and is highly species diverse. Planted Douglas-fir are quite numerous throughout the stand existing generally as evenly spaced larger trees. Western hemlock is prolific occupying a wide range of tree sizes and dominating many locations. Stand densities range from slightly overstocked to several plots containing in excess of 4,000 tpa. Outside the western and southern boundaries red alder dominates with a shorter component of western hemlock. In many locations within Unit 50.1 red alder is dominant with a similar understory of western hemlock. Although it is surrounded by second-growth forest, Unit 50.1 is near a patch of old growth with confirmed marbled murrelet nesting. Post-thinning snow toppling of western hemlock is a concern. Unit 50.2 contains larger trees and with no to minimal understory. Certain sections, notably the southwestern portion, are stagnating with very little differentiation.

Table 6. Unit 50 pretreatment data summary

		average TPA						range TPA					
Unit	n	total	ABAM	TSHE	PSME	THPL	ALRU	total	ABAM	TSHE	PSME	THPL	ALRU
50.1	9	4,672	672	2,922	894	50	133	100-15,5	0-3,500	200-11,750	0-2,250	0-250	0-800

Objectives specific to Unit 50

- Increase diversity of minority species; maintain presence of Douglas-fir
- Maintain tree growth and decrease density
- Enhance variability of tree spacings
- Increase differentiation of co-dominants and dominants

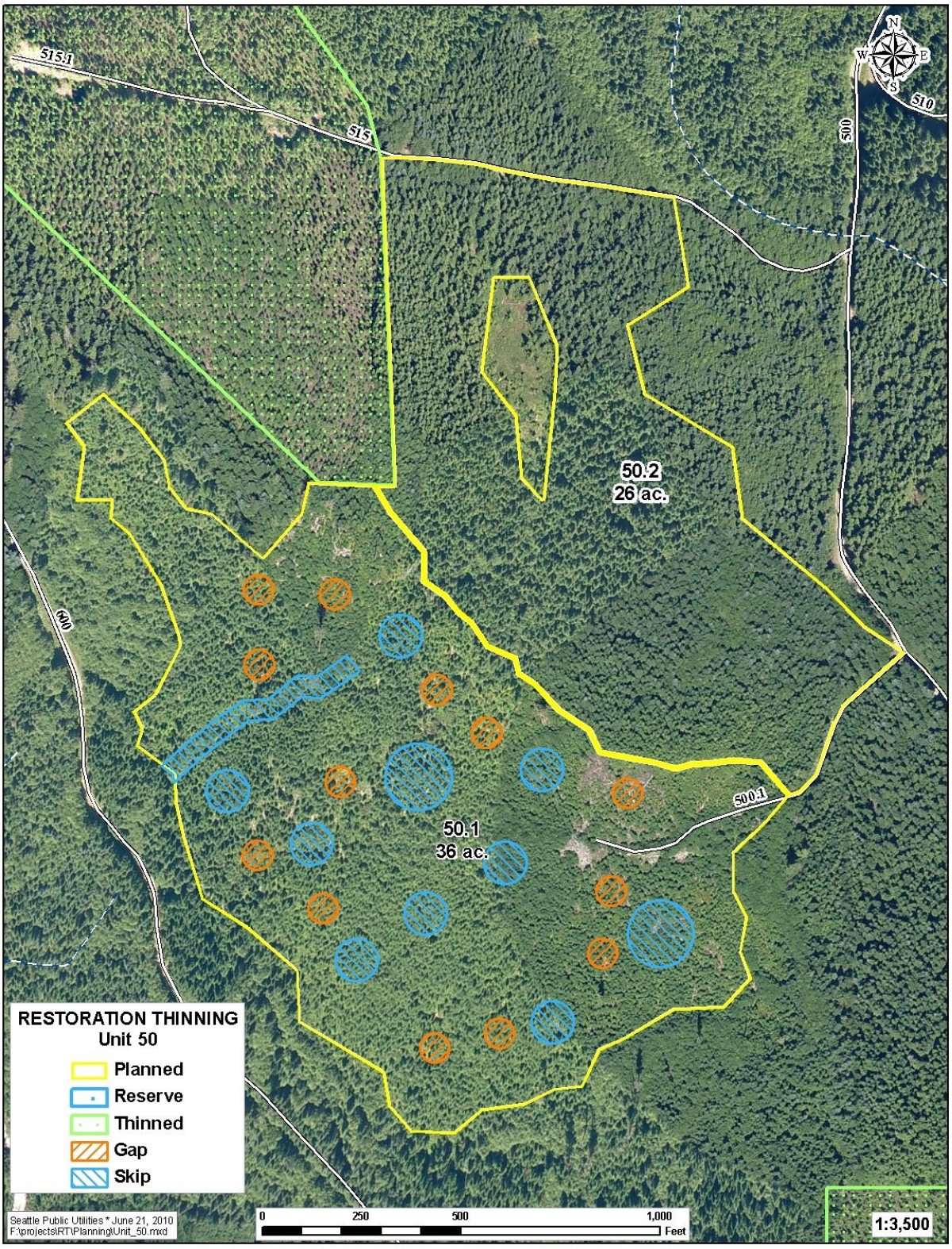


Figure 8. Unit 50.

Unit Summary

Unit 50.1 – In order to maintain the presence of Douglas-fir and decrease the proportion of western hemlock, all western hemlock within 10' of a Douglas-fir will be cut while also spacing Douglas-fir 16'x16'. Any remaining western hemlock will be retained to provide continued support for each other to resist bending from snow. The remaining species, e.g., western red cedar, red alder, silver fir, noble fir, western white pine, shall all be retained to maintain species diversity and horizontal variability. A maximum cut limit of 6.5" dbh will also maintain or increase the horizontal variability in tree spacings.

Post-Treatment – A total of 21-1/50th ac. plots were installed: ten measure and eleven tally plots. Compliance measured in Unit 50.1 was 93% based on the quality calculation. The total residual density of 590 tpa does not adequately reflect the stand as two plots out of ten contained 94% of all silver fir recorded and were very dense (1,250 and 2,150 total tpa). Stand density is more accurately reflected in Douglas-fir (175 tpa), western and mountain hemlock (95 tpa), noble fir (5 tpa), and red alder (5 tpa). While the high density associated with silver fir is limited to the northeastern portion of the unit, the thinning of silver fir similar to hemlock would have increased spacing to Douglas-fir while still retaining variability of dense silver fir patches.

50.2 – Given the larger trees sizes and differences within the unit as to the degree of differentiation, marking of cut and/or leave trees will be done by watershed staff. The objectives will be to release underrepresented species and select co-dominant and dominant trees. Prescriptions will utilize individual-tree release, multiple-tree release in 1/10th to 1/5th acre in size, and 1/5th acre treed gaps containing 2-3 residual conifers in patches of alder. Western red cedar will be planted in the gaps and other suitable locations. Overall, 20% of Unit 50.2 will be treated through thinning and snag creation.

Post-Treatment – No thinning was conducted in 2010.

4.7 Unit 54 (202 acres)

Unit 54 has widely variable pre-treatment canopy structure consisting of wind whipped trees, shrubs, rocky outcrops, and closed canopy silver fir trees. The unit was harvested between 1970 and 1987 with current tree heights generally correlating with the time of harvest. The southeast side of the ridge appears to be heavily impacted by the wind with tree crowns heavily flagged and missing many needles. Pine Creek borders Unit 54 at the bottom of the slope, old-growth forest abuts the southeast corner, and second-growth forest and previously thinned young forest occur on the west side of the unit.

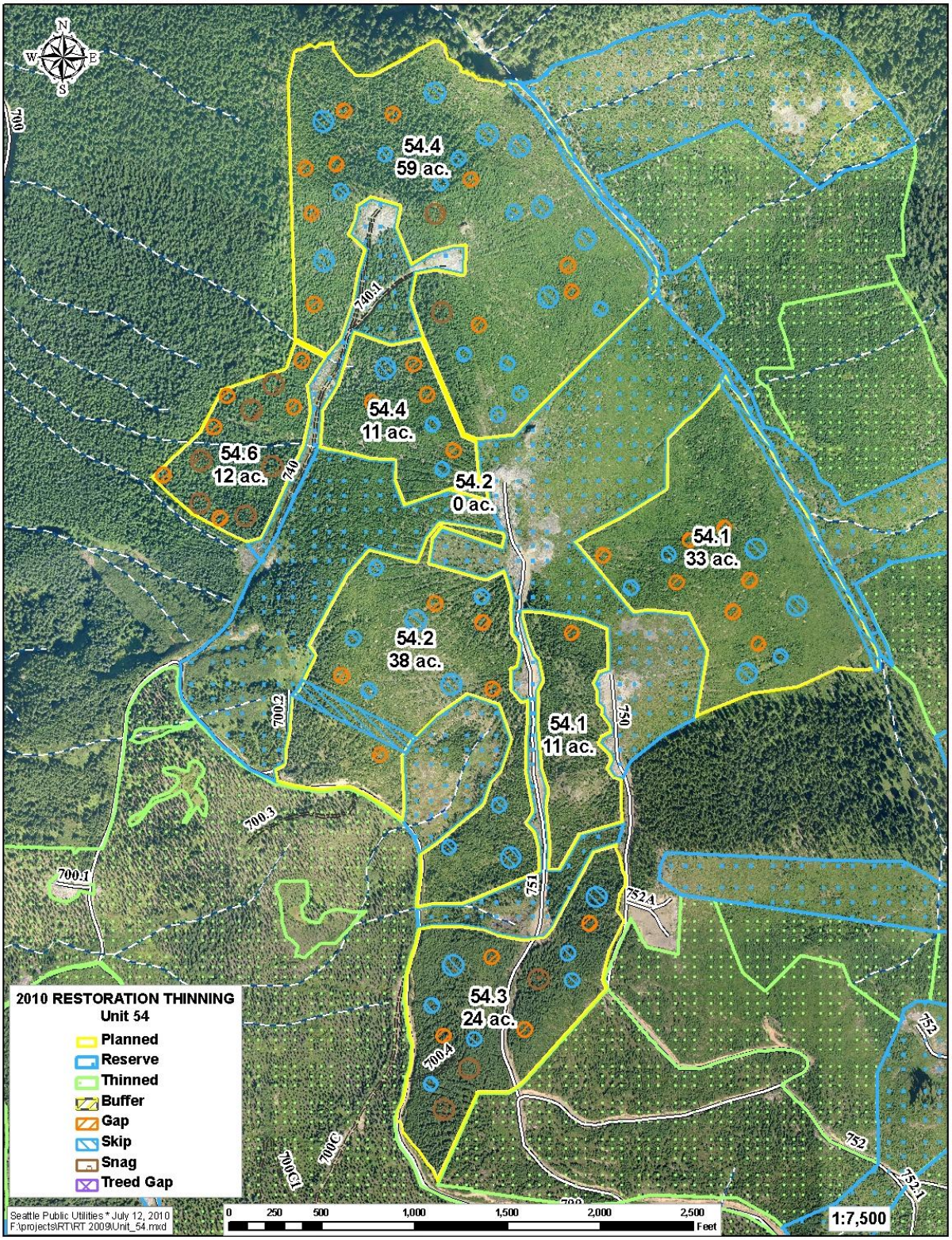


Figure 9. Unit 54.

Table 7. Unit 54 pretreatment data summary

		average TPA				range TPA			
Unit	n	total	ABAM	TSME	TSHE	total	ABAM	TSME	TSHE
54	29	3,050	2,810	225	15	0-11,500	0-11,000	0-3,000	0-500

Objectives specific to Unit 54

- Skip or identify as reserves special features such as rocks, meadows and brushy areas;
- Minimize visual presence of yarding corridors;
- Increase tree species diversity;
- Minimize further wind damage to trees.

Unit Summary

Unit 54.1 – Tree densities and height growth appear to be relatively low in Unit 54.1. Second-growth forests to the northwest of this unit are very slow growing, potentially due to soil disturbance from cable yarding and loss of needles from wind. The effects within the unit do not appear to be as severe as those neighboring it. Because of the low site quality, to lessen the impact wind will have on thinned trees, and to create variability across stands, Unit 54.1 was chosen to have a narrow spacing of 12'x12'. Gaps, skips, and planting in the gaps and yarding corridors will complement the narrow spacing.

Post-Treatment – A total of eleven 1/50th ac. plots were installed: five measure and six tally plots. Compliance measured in Unit 54.1 was 95% based on the quality calculation. A four acre portion of the unit was left un-thinned as the cost of thinning increased and was determined to be low priority for completion due to slow growth in the upper portion of the unit. The target density of 300 tpa was met with most in silver fir (290 tpa) and a minor amount of mountain hemlock (10 tpa). No tree planting was conducted for either increasing species diversity or augmenting natural regeneration.

54.2 – Impacts from the logging can be observed in the lack of trees established in the yarding corridors and in the adjacent Reserve to the southwest that is surrounded by 54.2. Planting will occur in all gaps, yarding corridors and sparse areas throughout the unit. The remaining area is dominated by closed canopy forest. A 16'x16' spacing with a no cut limit of 6" dbh will create small scale patchy structure throughout this dense stand. The linear contour skip creates connectivity for amphibian travel between the riparian areas.

Post-Treatment – A total of 22-1/50th ac. plots were installed: eleven measure and eleven tally plots. Compliance measured in Unit 54.2 was 91% based on the quality calculation. A one acre portion of the unit in the far north end was unthinned as the cost of thinning increased. It was determined to be low priority for completion as it

forms a connection between Reserves at the top of the ridge and Unit 54.4. Only two silver fir were recorded over 6" dbh indicating that the diameter cut limit was set too high to impact tree retention and spatial patterns. With total residual density of 323 tpa, silver fir dominates (195 tpa), followed by western hemlock (82 tpa) and mountain hemlock (45 tpa). A diameter cut limit of 4" and wider spacing for silver fir would have decreased overall density and increased proportion of minor species.

54.3 – With relatively high tree densities, large tree sizes and almost exclusively silver fir species composition, thinning by diameter in 54.3 will create variable densities without reducing the ability of other species to grow. Skips and gaps will increase the patchy structure of the unit at a slightly larger scale than the thinning prescription. In the 1/5th acre patches, girdling trees greater than 5" dbh and leaving two trees in the middle will reduce the slash on the ground immediately after thinning and provide short-term snags for wildlife use.

Post-Treatment – A total of fourteen 1/50th ac. plots were installed: nine measure and four tally plots. Compliance measured in Unit 54.3 was 100% based on the quality calculation. Using a diameter cut limit of 5.5" dbh yielded 328 tpa comprised of silver fir (289 tpa), western and mountain hemlock (17 tpa each), and noble fir (6 tpa). Since this unit has the tallest trees the high residual density creates a different structure than surrounding units thereby increasing inter-stand variability.

54.4 – The largest unit at 82 acres, 54.4 encompasses the west and east flanks of the ridge separating Pine and Rex Creeks. As with Unit 54.3, almost the entire unit is covered by closed canopy forests. Thinning of only silver fir by diameter will be used to increase tree growth, increase patchy structure and decrease silver fir dominance. Skips and gaps throughout the unit will increase the patchy structure further at a larger spatial scale.

Post-Treatment – A total of 22-1/50th ac. plots were installed: eleven measure and eleven tally plots. Compliance measured in Unit 54.4 was 92% based on the quality calculation. Total residual density is 536 tpa comprised of silver fir (250 tpa), western hemlock (136 tpa), western red cedar (95 tpa), mountain hemlock (50 tpa) and noble fir (5 tpa). For trees greater than 4.5' in height the total is 414 tpa. For residual silver fir, none are greater than the diameter cut limit of 9" dbh. A different prescription emphasizing the release and spacing around minor species would more closely achieve the objectives. Alternatively, a significantly lower diameter cut limit (4" dbh) and a wider spacing (18'x18') would have reduced silver fir dominance. The portion south of the stream skip was left unthinned as the cost of thinning increased. It was determined to be low priority for completion as it forms a connection between Reserve areas at the top of the ridge and Unit 54.6.

54.6 – The trees within Unit 54.6 are too tall to thin safely and would create heavy slash accumulations so instead gaps and snag patches will be made throughout this twelve acre unit. Patches 1/5th acre in size will have two trees left in the middle with trees over 5" dbh girdled and the remaining felled followed by planting. This unit is

on the edge of larger forest to the north and is a transition to the smaller trees in the rest of Unit 54.

Post-Treatment – The prescription for this unit involved creating gaps and snag patches with no thinning in the matrix. Western red cedar was cut in the first couple of gaps and one snag patch in the northeast portion. The contractor quickly rectified mistakes and completed the unit with greater accuracy. No compliance data was taken.

4.8 Unit 71 (17 acres)

Unit 71 was included after initial planning for all other units was completed due to the imminent decommissioning of the road. Residing below the old-growth in Shotgun Creek the trees are shortest and densest at the top of the slope increasing in size and decreasing in density towards the bottom of the unit. Species diversity is high with most of the silver fir present at the top of the unit with Douglas-fir and western hemlock dominating below the road.

Table 8. Unit 71 pretreatment data summary

		average TPA					range TPA					dbh	height
Unit	n	total	ABAM	PSME	TSHE	THPL	total	ABAM	PSME	TSHE	THPL	avg	avg
71	3	1,233	267	233	667	67	1,000-1,400	0-500	0-400	0-1,000	0-200	2.5	16

Objectives specific to Unit 71

- Maintain and enhance tree growth
- Increase proportions of minor species

Unit Summary

Unit 71 – In order to maintain and increase species that are normally underrepresented in other stands, the species preference for retention is western red cedar (no cut), Douglas-fir, noble fir, western hemlock, and silver fir. A spacing of 15'x15' with a maximum cut limit of 6" dbh will provide optimum growth for the variety of species retained.

Post-Treatment – A total of eleven 1/50th ac. plots were installed: seven measure and four tally plots. Compliance measured in Unit 71 was 95% based on the quality calculation. Total residual density is 400 tpa comprised of silver fir (136 tpa), western red cedar (123 tpa), Douglas-fir (68 tpa), and western hemlock (55 tpa). The majority of western red cedar were clumped saplings and 32% of retained trees are larger than the diameter cut limit of 6" dbh. Both objectives were met although potentially more silver fir could have been cut to increase growing space for other species.

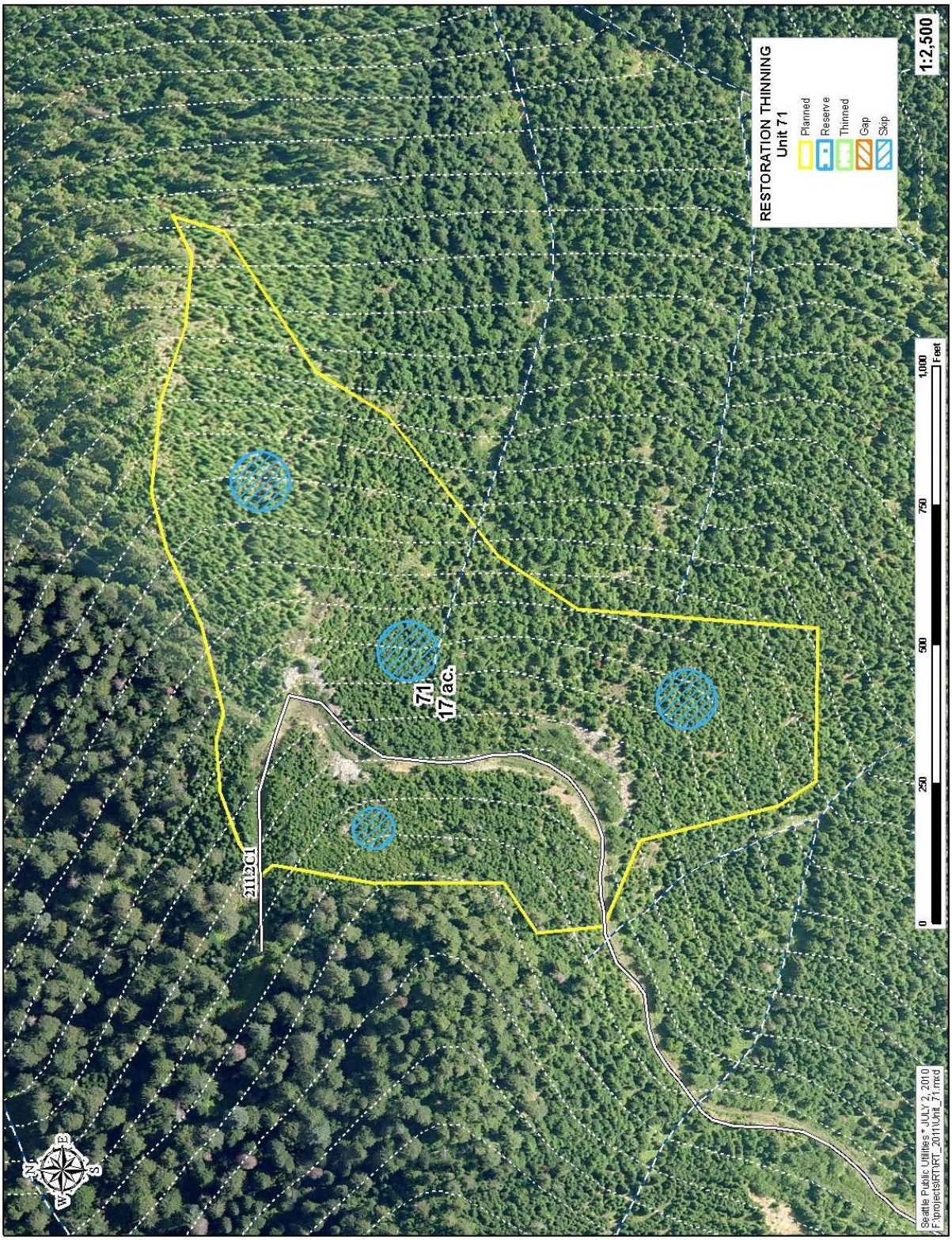


Figure 10. Unit 71.

4.9 Unit 89 (54 acres)

Unit 89 is highly variable with dense areas dominated by Douglas-fir or silver fir, and shrub/bear grass patches with few trees. Significant areas also exist where current tree densities are acceptable without the need for thinning or planting. Tree densities are extremely high on north aspects of two inner gorges as well as between the 510 road and the old growth at the top of the unit. Elevation ranges from 2,500' to 3,800' with an accompanying change in species dominance from Douglas-fir to silver fir. At lower elevations (Unit 89.1) there are significant components of western hemlock, silver fir and noble fir but it is still dominated by Douglas-fir. Units 89.3 and 89.4 are dominated by silver fir. Old-growth stands flank the eastern side of the unit.

Table 9. Unit 89 pretreatment data summary

		average TPA						range TPA					
Unit	n	total	ABAM	PSME	TSHE	ABPR	THPL	total	ABAM	PSME	TSHE	ABPR	THPL
89.1	6	4,483	700	2000	983	767	33	200-6,750	100-1,300	0-4,000	0-1,250	0-1,500	0-100
89.3	6	5,250	4,208	83	708	167	83	2,000-8,500	1,000-8,500	0-500	0-3,000	0-500	0-500

Objectives specific to Unit 89

- Maintain inter-tree and within-patch variability
- Increase edge growth of silver fir while maintaining clumpiness
- Protect slope stability in steep inner gorges

Unit Summary

Unit 89.1 – In order to maintain the patchiness of the unit while still allowing for increased growth of Douglas-fir, a prescription was developed that cuts all silver fir within 8' of a Douglas-fir while also spacing Douglas-fir 16'x16'. Leaving trees less than 3' in height and greater than 6.5" dbh will also increase the heterogeneity of tree spacing. Numerous skips and gaps add further to the patchiness.

Post-Treatment – A total of eighteen $1/50^{th}$ ac. plots were installed: nine measure and nine tally plots. Compliance measured in Unit 89.1 was 99% based on the quality calculation. Residual density is 373 tpa dominated by Douglas-fir (163 tpa) followed by western hemlock (123 tpa), red alder (57 tpa), silver fir (20 tpa), noble fir (7 tpa), and western red cedar (3 tpa). Density of Douglas-fir ranges from 100 to 250 tpa with an average close to the desired average density. Only three trees recorded exceeded the diameter cut limit. The six densest plots contained the highest densities per plot of western hemlock and red alder indicating that hemlock is still dense at least on some plots thereby meeting one objective. For the five plots 250 tpa and less, Douglas-fir is the dominant tree on three plots and counts for half the trees on two plots.

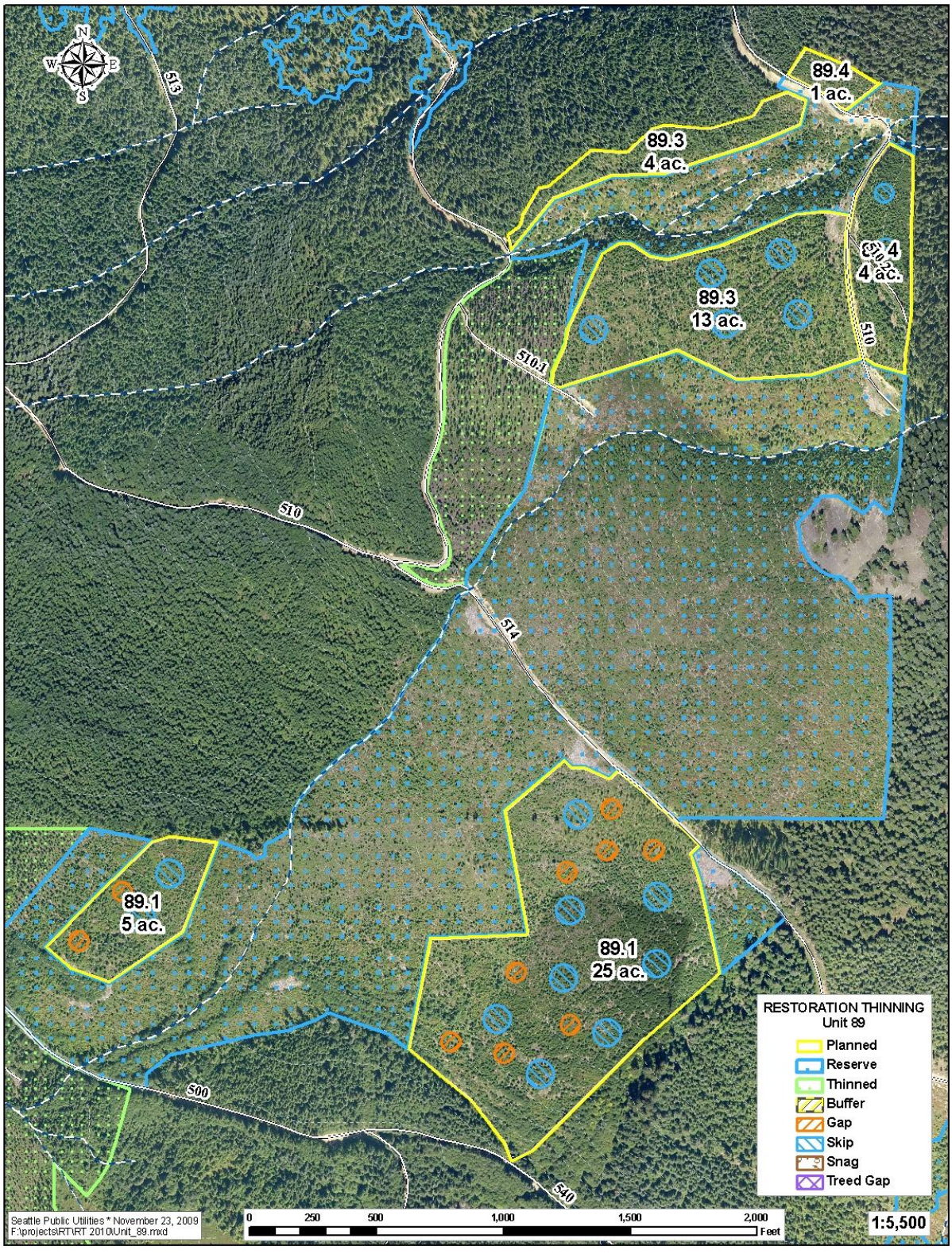


Figure 11. Unit 89.

89.3 – Silver fir dominates this unit and in some places exists at extremely high densities. It is bordered by very dense trees of the same age buffering the inner gorge, older dense stands to the north and a low density Reserve to the south. In order to give moderately shade-intolerant species Douglas-fir and noble fir adequate growing space, silver fir within 18' of those species will be cut. For the rest of the silver fir 14'x14' spacing will be used. Leaving trees less than 3' in height and greater than 6.5" dbh will also increase the heterogeneity of tree spacing.

Post-Treatment – A total of nine 1/50th ac. plots were installed: six measure and three tally plots. Compliance measured in Unit 89.3 was 90% based on the quality calculation. Residual tree density is 300 tpa dominated by western hemlock (139 tpa) followed by Douglas-fir (78 tpa), silver fir (56 tpa), noble fir and mountain hemlock (11 tpa), and lastly western red cedar (6 tpa). The thinned stand contains relatively few silver fir compared to pre-treatment densities although western hemlock densities also show decreases even though they were not cut (a sampling issue). The objective of increasing tree growth on Douglas-fir was accomplished but little can be quantified with regards to increasing spatial heterogeneity or providing edge growth to silver fir.

89.4 – Bordering old growth in a narrow strip, Unit 89.4 is a dense stand comprised of silver fir with a minor component of hemlock. In order to promote minor species, silver fir within 16' of Douglas-fir, noble fir and hemlock will be cut. The remaining silver fir will be spaced at 12'x12' spacing, with a 6.5" maximum diameter cut limit.

Post-Treatment – A total of five 1/50th ac. Measure plots were installed. Compliance measured in Unit 89.4 was 90% based on the quality calculation. Residual tree densities of 340 tpa is dominated by silver fir (260 tpa) followed by western hemlock (50 tpa) and mountain hemlock (30 tpa). Unit 89.4 was the densest unit of all 2010 Restoration Thinning units. Given the high initial density the objectives created are reasonable and were easily accomplished.

4.10 Unit 90 (18 acres)

Unit 90 is comprised mostly of uniform Douglas-fir with western hemlock at similar heights as well as significantly shorter. More than half of Unit 90 was pre-commercially thinned in 1995 to 12'x12' spacing with the remaining area receiving no thinning. Even with thinning the majority of 90.3, western hemlock densities are still higher than in 90.2, albeit in thick clumps. Given the low densities in similar, neighboring stands, Unit 90 is not excessively overstocked when viewed on landscape scale. Planting of minor species is planned for both gaps and in areas not planned for thinning.

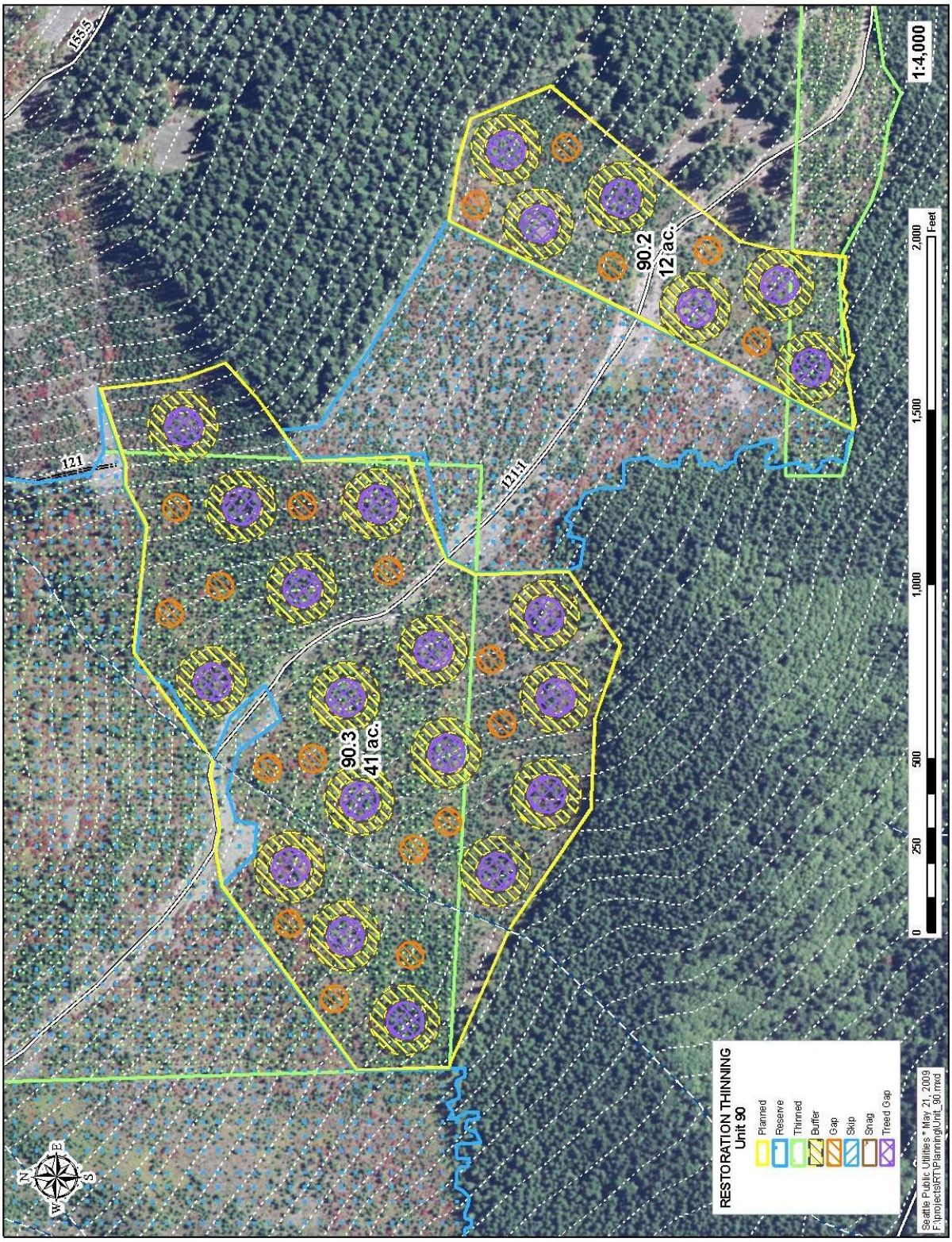


Figure 12. Unit 90.

Table 10. Unit 90 pretreatment data summary

		average TPA							range TPA						
Unit	n	total	ABAM	PSME	TSHE	ABPR	THPL	ALRU	total	ABAM	PSME	TSHE	ABPR	THPL	ALRU
90.2	3	633	-	533	67	33	-	-	400-1,000	-	300-800	0-200	0-100	-	-
90.3	6	1975	167	750	1017	42	67	250	0-5,000	0-1,000	0-1,500	0-2,500	0-250	0-400	0-1,500

Objectives specific to Unit 90

- Maximize tree growth on select trees
- Increase clumpy distribution
- Maintain and enhance species diversity

Unit Summary

Units 90.2 and 90.3 – Prescriptions for 90.2 and 90.3 are identical with small differences in tree densities and size. In order to increase the heterogeneity of inter-tree spacing a series of gaps and treed gaps with 16'x16' spacing buffers will be utilized. No remaining trees will be cut in the matrix. Western white pine, western red cedar, noble fir and hardwoods will be retained throughout the units. Matrix thinning throughout the stand would lower stand densities to that of adjoining stands and increase the homogeneity of tree spacing, therefore it is not being done. Planting in gaps will follow thinning operations.

Post-Treatment – No post-treatment compliance data was taken although inspection was accomplished by visual assessment of pass/fail. The objectives of increasing heterogeneity at the tree scale were achieved by the increased number of small openings and widely spaced edge trees. The planting of underrepresented species (western white pine and noble fir) in gaps increased species diversity. Layout of the two different gap types was very time intensive requiring significant staff time to flag boundaries in support of the thinning crew. The outcome created from a gap and buffer of widely spaced trees was very favorable and should be repeated.

4.11 Unit 138 (17 acres)

Unit 138 was not initially included in the restoration thinning candidate pool due to tree heights in excess of 30'. However, tree diameters are small enough to be safely thinned. Tree densities are very high and uniform throughout the unit. Tree densities decrease and diameters increase to the north, west and south. Slope angle increases significantly on the northern edge approaching Bear Creek. Unit 138 is bordered by old-growth on the east that experienced a significant amount of edge blowdown presumably after the cutting of Unit 138 in 1957 and 1960. Silver dominates most of the unit but western hemlock is present in significant numbers on portions of the unit.

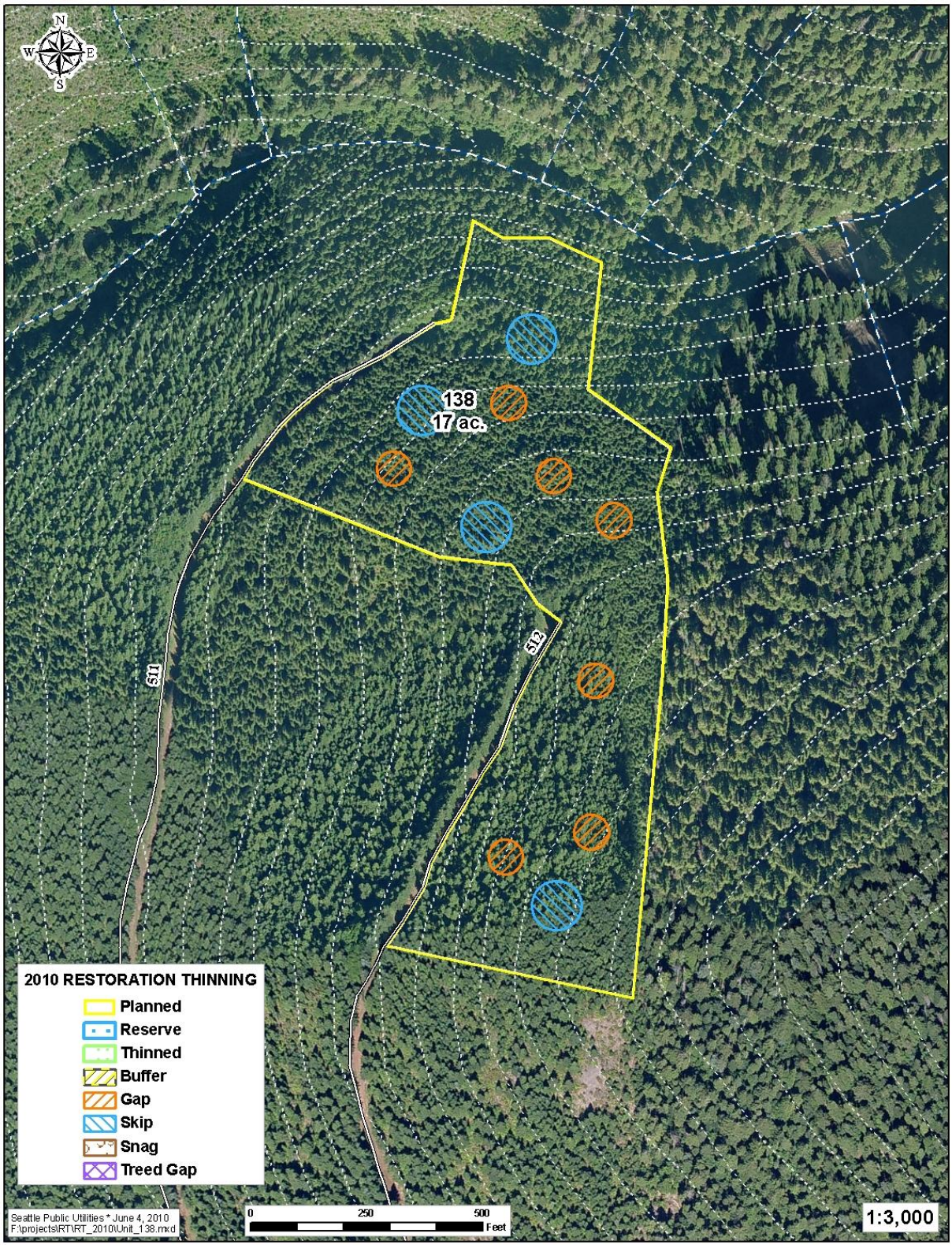


Figure 13. Unit 138.

Table 11. Unit 138 pretreatment data summary

		average TPA					range TPA					dbh	height
Unit	n	total	ABAM	PSME	TSHE	ABPR	total	ABAM	PSME	TSHE	ABPR	avg	avg
138	6	3792	3208	42	500	42	1,750-8,750	250-8,750	0-250	0-1,250	0-250	6.1	43

Objectives specific to Unit 138

- Increase tree growth on select trees
- Increase horizontal spatial variability
- Reduce dominance of silver fir relative to minority species
- Protect residual trees against increases in potential windthrow
- Maintain and increase understory vegetation

Unit Summary

Unit 138 – Although tree sizes in Unit 138 are generally larger than desired for restoration thinning, the proximity to old growth and Bear Creek, stem density, and lack of adjacent thinning strongly encourage the use of thinning treatments in this stand. Prescriptions will eliminate hemlock below 4" dbh and thin silver fir less than 8" dbh to 14'x14' spacing including other species in the spacing. Girdling will be done on trees between 6" and 8" dbh to reduce the thinning slash.

Post-Treatment – A total of eight 1/50th ac. plots were installed: four measure and four tally plots. Prescriptions initially did not include removal of hemlock below 4" dbh but were added after initial cutting revealed a greater than desired number of residuals in this size range. Changes in prescriptions were not adequately communicated to the compliance inspector leading to an incorrect assumption of the desired leave trees and inability to assign a quality calculation. Residual stand density is 350 tpa with near equal portions of western hemlock (175 tpa) and Douglas-fir (125 tpa) followed by silver fir (50 tpa). Unit 138 was not initially included in the Restoration Thinning candidate pool due to the tall tree heights. The objective of reducing silver fir dominance relative to minor species was achieved given the lower silver fir representation post-thinning and the larger proportion of Douglas-fir. Additionally this unit utilized numerous species, diameter and spacing prescriptions that were altered as cutting progressed to better achieve objectives. Unfortunately the complex prescriptions were confusing to some individuals who mistakenly cut species that were not to be cut.

5.0 Slash Treatment

To minimize restoration thinning effects on growth of big huckleberry, increase berry production and improve access, thinning related slash was treated in Unit 16.2. The treatment required slash to be lopped and piled into 6' diameter piles. Based on the 2008 Slash Treatment Trial this appears to be the best, most cost-effective method for

achieving goals of improving access to huckleberry and growing conditions. In total, six acres were lopped and piled in Unit 16.2 resulting in increased access and understory growth. Muckleshoot Indian Tribe (MIT) provided funding for the slash treatment with watershed staff contributing planning and project oversight. Additional area was treated in Rex and Rack/Lost Creek drainages. The total of acres treated is estimated at 32.5 acres: 15.0 acres of entire thinning (covering the whole area), 10.3 acres in gaps and 7.2 acres in corridors.

6.0 Planting

In coordination with the Upland Restoration Planting Program, the thinned matrix and gaps in several units were planted in addition to understocked Reserves. Planting objectives are to diversify species composition, increase riparian cover, bank stability and nutrient inputs, and increase stocking densities, where needed. Different mixes of species will be used for different planting situations depending upon existing conifer species present at that site, elevation, aspect, site quality, understory light availability, and seedling availability. In total nearly 13,000 trees were planted across 126 acres in 2010. See the 2010 Restoration Planting As-Built Accomplishment Report for more detailed information.

7.0 Threatened Species Protections

All of the 2010 restoration thinning units in North Shore Cedar and North Fork Cedar are located close to, or adjacent to, old-growth forests. Only Unit 40 is near non-suitable habitat with work proceeding regardless of season. Avoiding any restoration thinning operational disturbance to marbled murrelets (MAMU), spotted owls (SPOW) and northern goshawks (NOGO) occupying or nesting in these old-growth forests resulted in the creation of guidelines referenced in this section of the Plan. For specific guidelines on performing work adjacent to old-growth forest patches, including forest patch and buffer sizes, time of day, seasonal restrictions and sunrise/sunset, see Table 12.

Option 1 involves suspending work till after August 31st with no surveys conducted. This is the most cautious option because it avoids any possible impacts to threatened species in case of missed detection of threatened species. Option 1 is also the most economical option as long as limiting the work season does not increase costs.

Option 2 is for stands between five and 420 acres and work before August 31st. The first surveys will be for marbled murrelet habitat surveys, and if suitable habitat is found, to be followed by presence/absence surveys. Survey costs for Option 2 will be low and performed by Fish and Wildlife staff.

Option 3 covers all three potentially impacted sensitive species: northern spotted owl, marbled murrelet and northern goshawk. Fish and Wildlife staff will first survey for suitable habitat, and if present, they will survey for detection of each species. Costs are

Table 12. Guidelines for the Protection of Sensitive Avian Species Associated with Old-Growth Forest Adjacent to Restoration Thinning Work Sites.

Options	1 - No Surveys	2 - MAMU Surveys	3 - Surveys for all 3 Species	Known Nest Sites (SPOW, NOGO) HCP Restrictions	Known Occupied Stands (MAMU) HCP & Recommended Restrictions
Planned Work Season	For work conducted **after August 31st and before March 1st**	For work conducted **between April 25th and August 31st**	For work conducted **beetween March 1st and August 31st**		
Old-growth Patch Size	**All patches >5 acres**	**5-420 acres**	**>420 acres**	Any forest patch that has a documented SPOW or NOGO nest	Any forest patch that has documented MAMU occupancy
Work Season Restriction	None	Only if surveys document MAMU occupancy	Only if surveys document nesting SPOW or NOGO, or MAMU occupancy	**No work within buffer beetween March 1st and August 31st**	No work season restriction required in HCP. **F&W recommends no work wtihin buffer beetween April 25th and August 31st.**
Time of Day Restrictions	None	Only if surveys document MAMU occupancy	Only if surveys document MAMU occupancy	None	**IF** work before August 31, HCP requires work within 0.25 mile buffer to be conducted only between 2 hours after dawn and 2 hours before dusk
Buffer Distance	None	0.25 mile	0.25 mile (SPOW, MAMU) or 0.5 mile (NOGO)	0.25 mile (SPOW) or 0.5 mile (NOGO)	0.25 mile
Surveys	None	Yes[1]	Yes[1]	Yes	Yes
Northern Spotted Owl (SPOW)	Avoids potential impacts to SPOW, which typically nest in stands >450 acres and are sensitive to activity within 0.25 mile prior to August 31st.	Not applicable - patch size too small	Two SPOW survey visits as soon as access allows, in the portions of old-growth forest patches >450 acres that are within 0.25 of the work .	Work season restrictions protects adults and chicks in nest from disturbance.	Not Applicable
Marbled Murrelet (MAMU)	Avoids potential impacts to MAMU, which typically nest in stands >5 acres and are sensitive to activity within 0.25 mile prior to August 31st.	Two MAMU survey visits over the early season prior to work, in portions of old-growth forest patches >5 acres that are within 0.25 mile of work.	Two MAMU survey visits as soon as access allows, in portions of old-growth forest patches >5 acres that are within 0.25 mile of work.	Not Applicable	Time of day restriction reduces disturbance during most active time of day for adults. Work season restriction protects adults and chicks in nest from disturbance.
Northern Goshawk (NOGO)	Avoids potential impacts to NOGO, which typically nest in stands >420 acres and are sensitive to activity within 0.5 mile prior to August 31st.	Not applicable - patch size too small	Two NOGO survey visits as soon as access allows, in the portions of old-growth forest patches >420 acres that are within 0.5 of work.	Work season restrictions protects adults and chicks in nest from disturbance.	Not Applicable
Relative Cost	No additional costs other than limiting the work season near all old-growth patches.	Low. Habitat and MAMU surveys will be conducted by F&W staff.	Low. All surveys will be conducted by F&W staff.	Low. Limits to work season near all nest sites. Surveys will be conducted by F&W staff for monitoring purposes.	Low. Limits to time of day or work season near all occupied sites. Surveys will be conducted by F&W staff for monitoring purposes.

greatest of all the three options but it covers the largest area and provides the most site-specific knowledge about species locations.

Future planning for restoration thinning will diversify project locations over the CRMW landscape whenever possible to provide options for conducting thinning projects in the event that seasonal restrictions are necessary to protect sensitive species. Protection requirements will not be arbitrarily applied to late-seral patches that are deemed too small for spotted owl or northern goshawk nesting or to forest patches where marbled murrelet occupancy has not been documented. If future surveys document additional findings of SPOW, MAMU, or NOGO in the CRMW, staff will celebrate those findings and develop and implement appropriate protective measures.

7.1 Marbled Murrelet

Surveys have documented marbled murrelet occupancy (presumably nesting) in two old-growth forest patches in the upper Cedar River Municipal Watershed (CRMW). The first location is in the central Rex Basin old growth and the second is adjacent to the main stem Cedar River near the confluence of the north and south forks. Since neither radar nor audio-visual surveys identified specific nest sites within these stands, the 0.25 mile buffer will extend outward from the outer perimeter of the old-growth forest patches. The HCP requires that within a 0.25 mile buffer around nest sites work may only occur between two hours after sunrise and two hours before sunset between April 1st and August 31st. Fish and Wildlife (F&W) staff recommend that we provide more conservative protection for these nesting sites and avoid all restoration thinning within the 0.25 mile buffer between April 1st and August 31st. After this date, work within the 0.25 mile buffer may proceed.

If restoration thinning work adjacent to other old-growth forest patches must be performed prior to August 31st, F&W staff will first determine whether the adjacent old-growth forest contains appropriate habitat for MAMU nesting. If the old-growth forest contains little or no nesting habitat, it will not be surveyed for MAMU occupancy and restoration thinning work can proceed. If the appropriate nesting habitat is present, F&W staff will survey for MAMU occupancy in the old-growth forest patches adjacent to proposed restoration thinning work. If no occupancy is found, restoration thinning work may proceed. If occupancy is found, then the restrictions discussed above would apply.

7.2 Northern Spotted Owl

Surveys conducted in 2005 and 2008 detected no nesting pairs of northern spotted owl, but the 2008 survey did document a lone male on the east side of the Findley Lake basin. The owl was found in this area several times throughout the summer. The possibility exists that this male will find a mate and nest in one of the old-growth forest patches in the upper CRMW or that another pair will move in. There are four patches considered large enough (>450 acres) to support a SPOW pair: Meadow Mountain, Tinkham/Abiel/Baldy, Findley Lake, and Goat Mountain patches. There are two other patches smaller in size than the owls require, but still present a remote possibility for

nesting habitat. These include the Rex Basin old-growth patch that provides high-quality habitat and the McClellan Butte patch that abuts late-seral forest outside the CRMW boundary.

If work adjacent to old-growth forest other than those listed above must be performed prior to August 31st, F&W staff will survey for spotted owls within 0.25 miles of the edges of these larger old-growth forest patches that are adjacent to planned restoration thinning work. These surveys will occur early in the season, prior to commencement of any thinning. If a nest site is found, the HCP requires that no work occur within 0.25 mile of the nest between March 1st and August 31st.

If surveys detect no nest site but do detect a transient owl, then F&W staff will use their best judgment on how to proceed given the location, potential habitat configuration in that area, and anticipated level of potential disturbance impact due to planned activities. It is possible that seasonal restrictions for SPOW protection will result in delayed project implementation through August 31st in this case as well. If no SPOW are detected, then work can proceed.

7.3 Northern Goshawk

There is one documented northern goshawk nest site in the CRMW in the Meadow Mountain old-growth forest patch just east of the 500 road gravel pit. The HCP requires a 0.5 mile buffer around all NOGO nest sites where no potentially disturbing work within this buffer is allowed between April 1st and August 31st.

NOGO require larger old-growth forest patch sizes (>420 acres) for nesting. The six patches described for SPOW are also potential nesting habitat for NOGO.

Early in the season F&W staff will survey for NOGO within 0.5 miles of the edges of these larger old-growth forest patches that are adjacent to planned work. If nesting NOGO are found, a 0.5 mile buffer around the nest will be established and the above restrictions apply. If no NOGO are detected, work can proceed.

7.4 2010 Surveys

Of the 10 units that are planned to be restoration thinned in 2010, only Units 40 and 54 were determined not to be adjacent to potentially suitable nesting habitat for MAMU, SPOW, or NOGO. Units 10, 16, 29, 89, and 138 were scheduled to be thinned after August 31st and therefore required no surveys. Units 14, 50, and 90 were scheduled to possibly be thinned prior to August 31st and therefore surveys were conducted to minimize potential thinning impacts to nesting by these sensitive species.

MAMU, SPOW, and NOGO surveys were conducted in potential habitat adjacent to both Units 14 and 90 on June 22-23 and June 29-30, 2010. Similar surveys were conducted in potential habitat adjacent to unit 50 on June 14-15 and June 25-26, 2010. No target species were detected.

8.0 Lessons Learned

In general, the objectives were consistently met in restoration thinning units. Contractors did a good job of following prescriptions and asking questions when unsure of specifications. In most cases, it appeared that the best trees were being retained. Many units were difficult to thin, due to the overly dense stocking of silver fir saplings. Contractors did an excellent job of keeping fire watch when appropriate, using spill pads, cleaning roads and ditches, and removing all trash from the work areas.

A summary of key lessons learned follows:

- The pre-work meetings at each unit in the field with the thinning crews this year were a great success with the new thinning contractors. This communication prevented most confusion upon starting new units.

- There were a few cases where verbal changes were missed by the compliance contractor who was not at the start of the unit. Any changes made in the field should be directly communicated to all parties in written and verbal form.

- We suggest that samples of trees that can be identified wrong by thinners be shown at pre-work meetings where those species are present. This change will especially help prevent cutting noble fir. There were repeat cases this year of leave tree species being cut in gaps or thinning areas. We need to demonstrate the importance of leaving these few trees uncut where prescriptions dictate this.

- It should be clearer in the text if the spacing is to be from just those in the thinning pool, or the "no cut" trees as well.

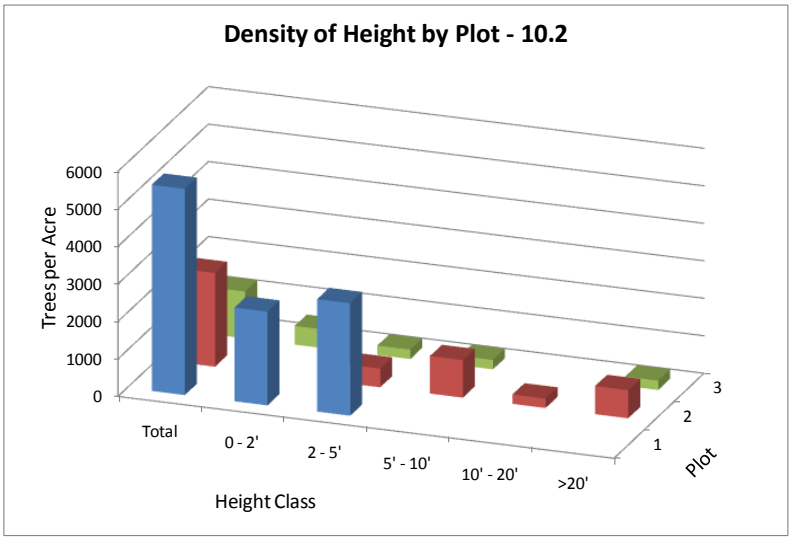
- The lack of pre-treatment data or sufficient site visits to ascertain species composition and/or tree sizes led to objectives not being fully achieved. In Unit 40, the presence of minor species was more than expected leading to higher overall densities and more competition to minor species. If the information had been known prescriptions could have been developed to decrease silver fir density and/or increase spacing around minor species. Generally, more site visits and/or pre-treatment data collection will create more accurate diameter cut limits to better increase spatial heterogeneity.

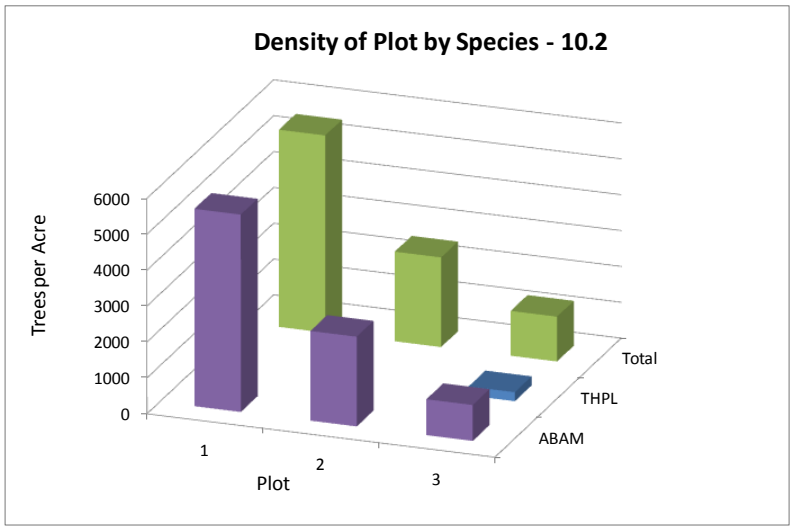
- Gap location could be better on steep slopes. Consider supplying thinning contractor with GPS.

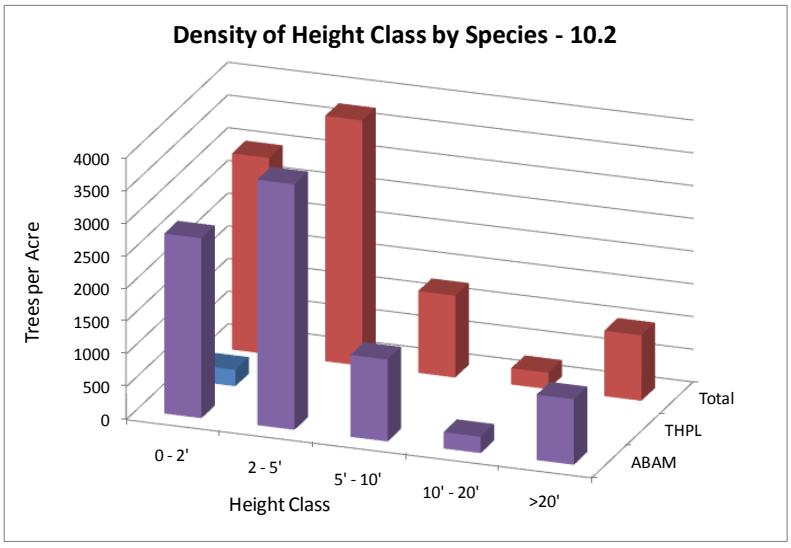
- Compliance GPS points should record unit number with plot number so that all data could be combined into one feature class. Create geodatabase for all past and future compliance data. Compliance plot locations should be mapped on the same overarching SPU grid as in the past so that different map prints all have the same plot location. Consider the creation of a data dictionary on GPS unit

Appendix A. Pre-treatment tree densities by plot, species and height class

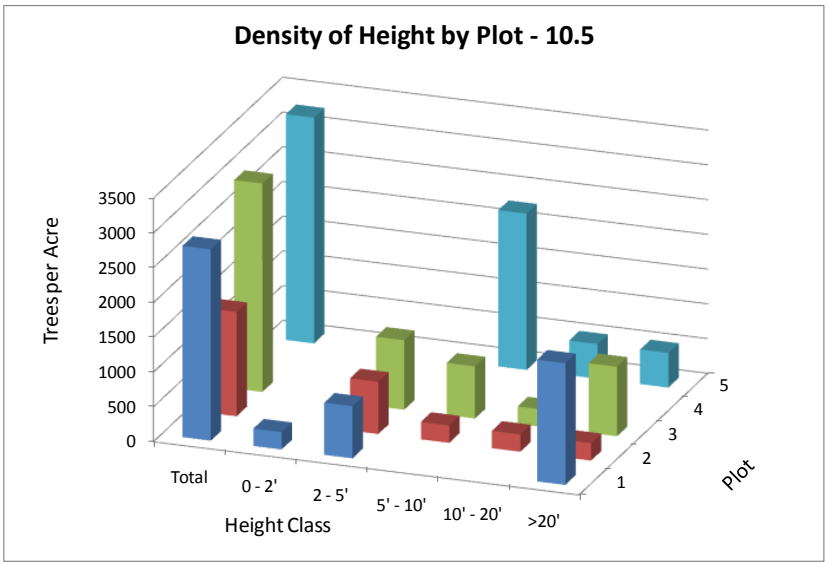
Unit 10.2

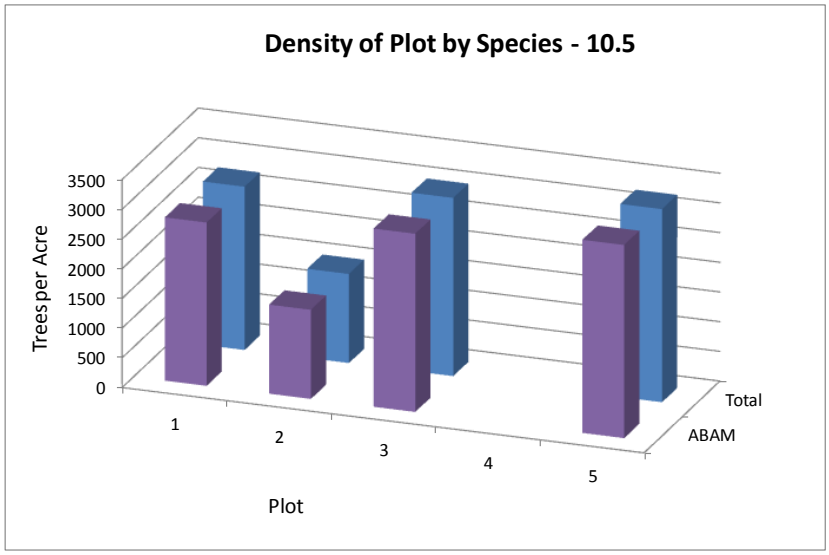


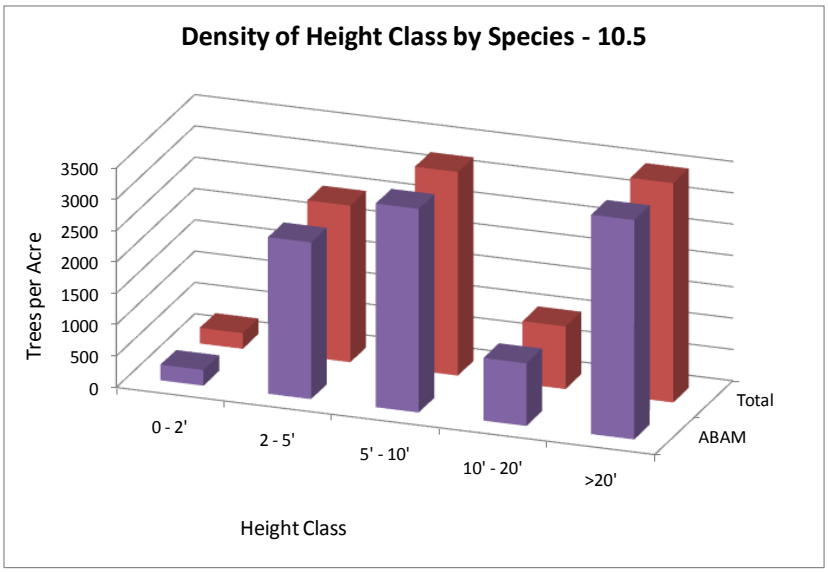




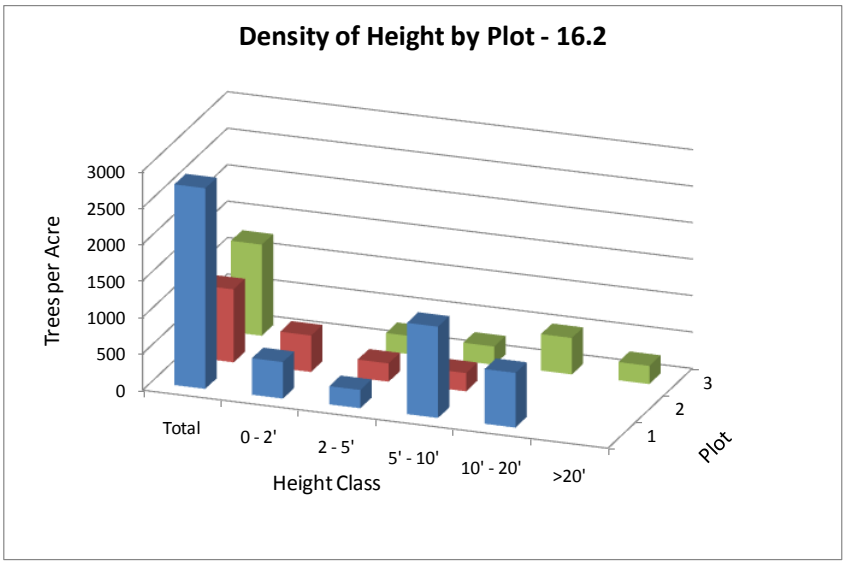
Unit 10.5

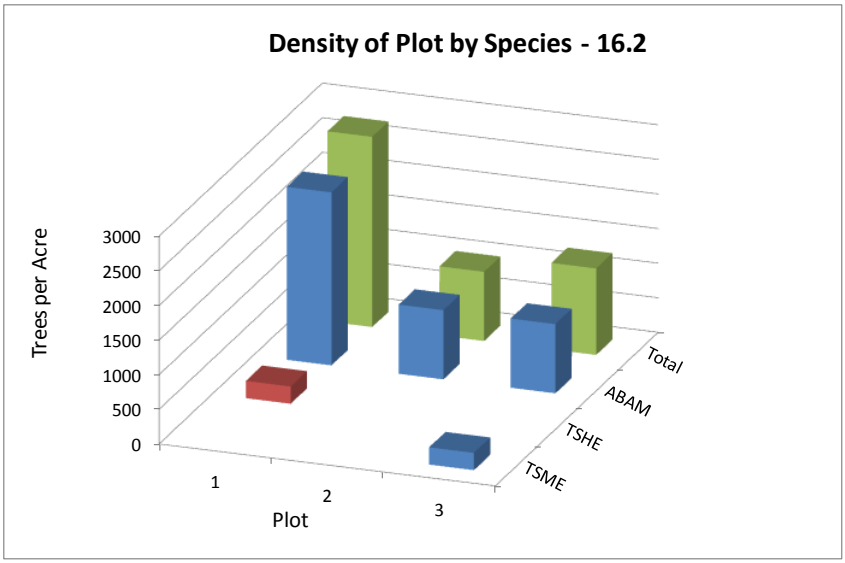

Density of Height by Plot - 10.5
Trees per Acre
3500
3000
2500
2000
1500
1000
500
0
Total
0 - 2'
2 - 5'
5' - 10'
10' - 20'
>20'
Height Class
1
2
3
4
5
Plot

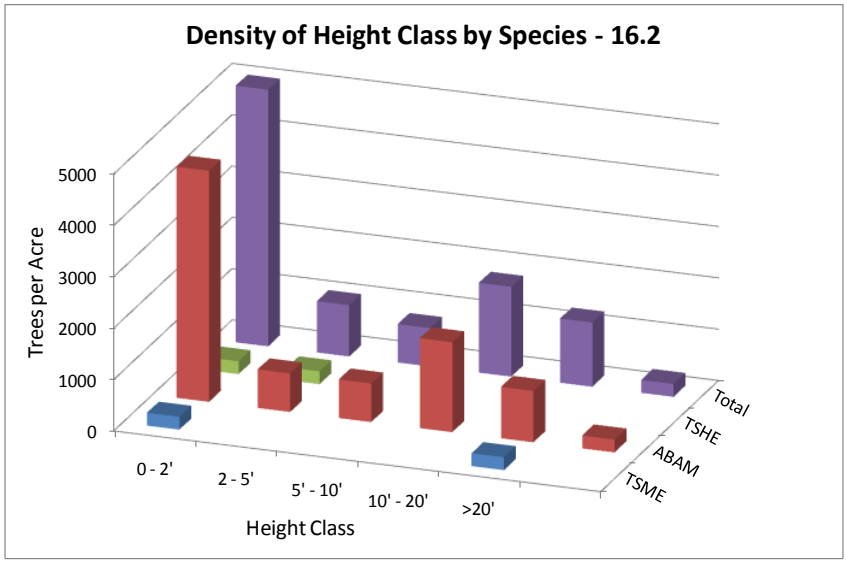

Density of Plot by Species - 10.5
Trees per Acre
3500
3000
2500
2000
1500
1000
500
0
1
2
3
4
5
Plot
Total
ABAM


Density of Height Class by Species - 10.5
Trees per Acre
3500
3000
2500
2000
1500
1000
500
0
0 - 2'
2 - 5'
5' - 10'
10' - 20'
>20'
Height Class
Total
ABAM

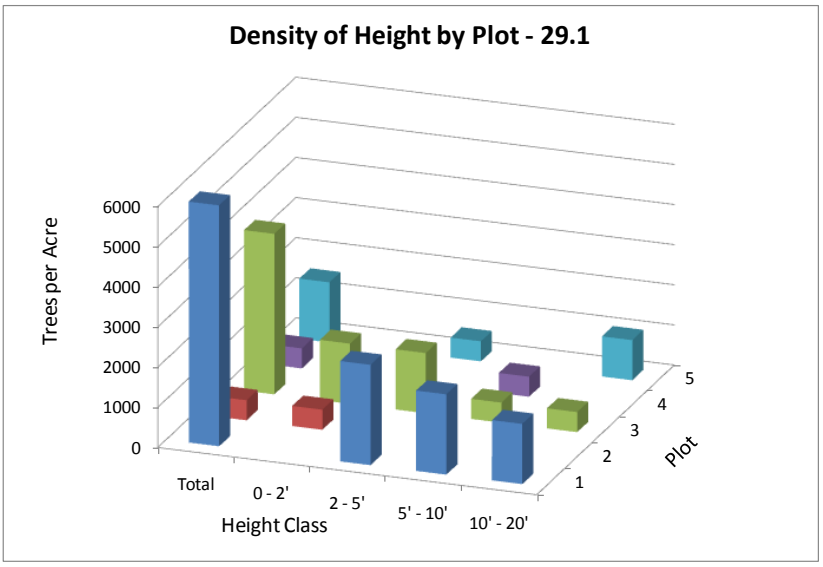
Unit 16.2

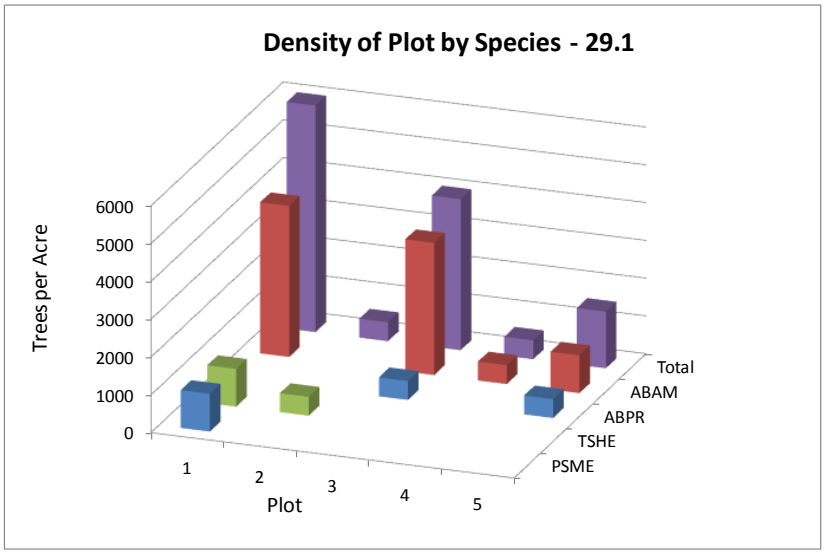

Density of Height by Plot - 16.2
Trees per Acre
3000
2500
2000
1500
1000
500
0
Total
0 - 2'
2 - 5'
5' - 10'
10' - 20'
>20'
Height Class
3
2
1
Plot

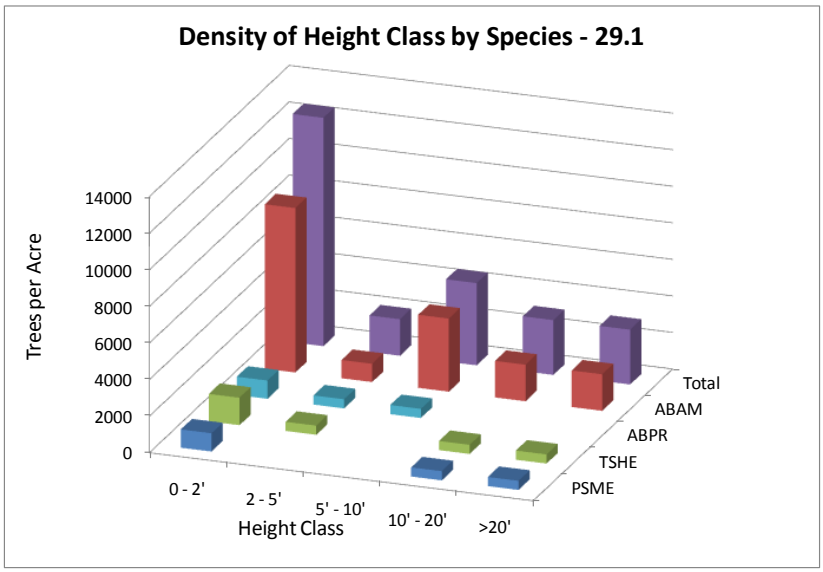

Density of Plot by Species - 16.2
Trees per Acre
3000
2500
2000
1500
1000
500
0
1
2
3
Plot
Total
ABAM
TSHE
TSME


Density of Height Class by Species - 16.2
Trees per Acre
5000
4000
3000
2000
1000
0
0 - 2'
2 - 5'
5' - 10'
10' - 20'
>20'
Height Class
Total
TSHE
ABAM
TSME

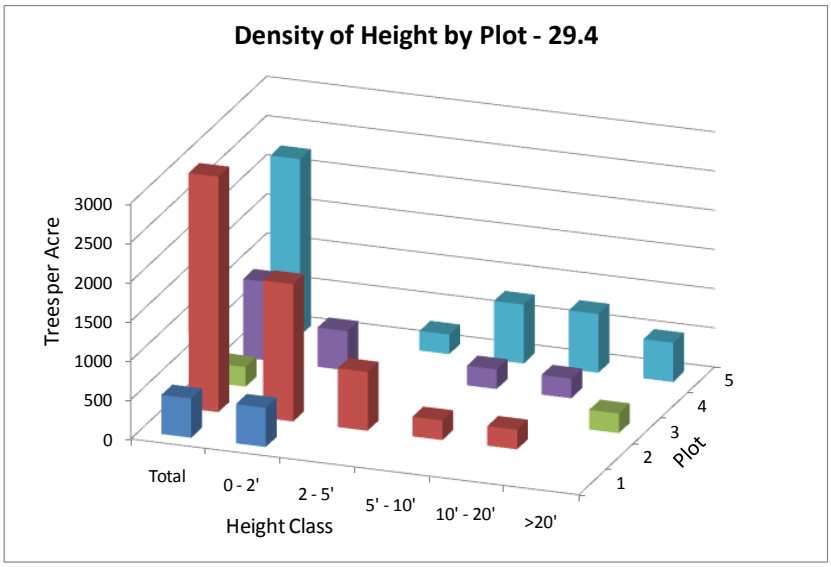
Unit 29.1

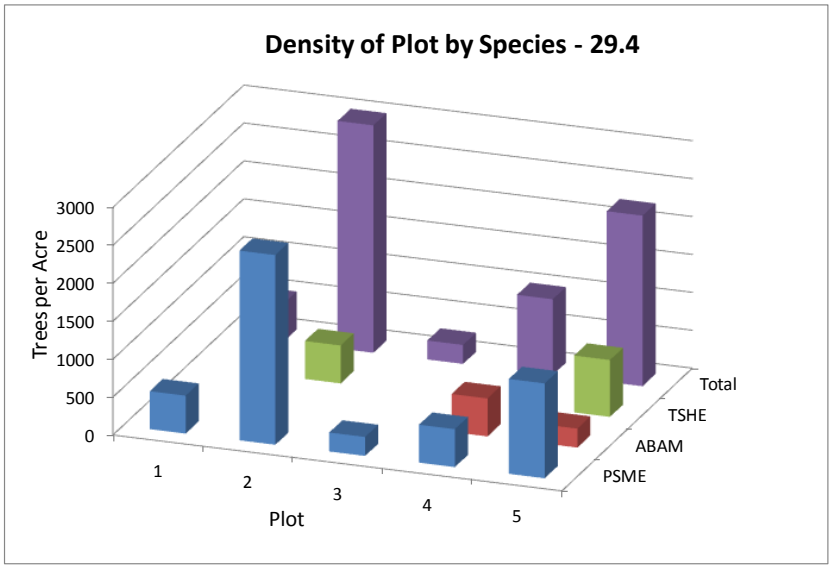

Density of Height by Plot - 29.1
Trees per Acre
6000
5000
4000
3000
2000
1000
0
Total
0 - 2'
2 - 5'
5' - 10'
10' - 20'
Height Class
1
2
3
4
5
Plot

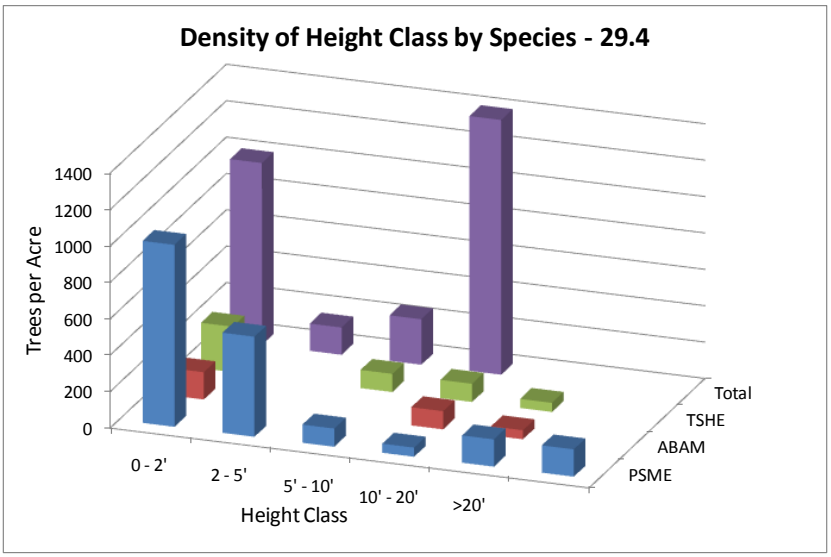

Density of Plot by Species - 29.1
Trees per Acre
6000
5000
4000
3000
2000
1000
0
1
2
3
4
5
Plot
Total
ABAM
ABPR
TSHE
PSME


Density of Height Class by Species - 29.1
Trees per Acre
14000
12000
10000
8000
6000
4000
2000
0
0 - 2'
2 - 5'
5' - 10'
10' - 20'
>20'
Height Class
Total
ABAM
ABPR
TSHE
PSME

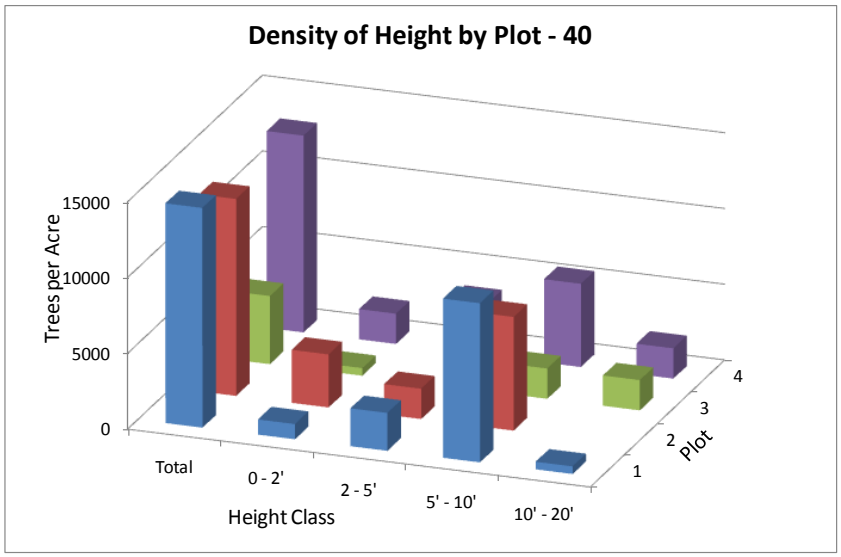
Unit 29.4

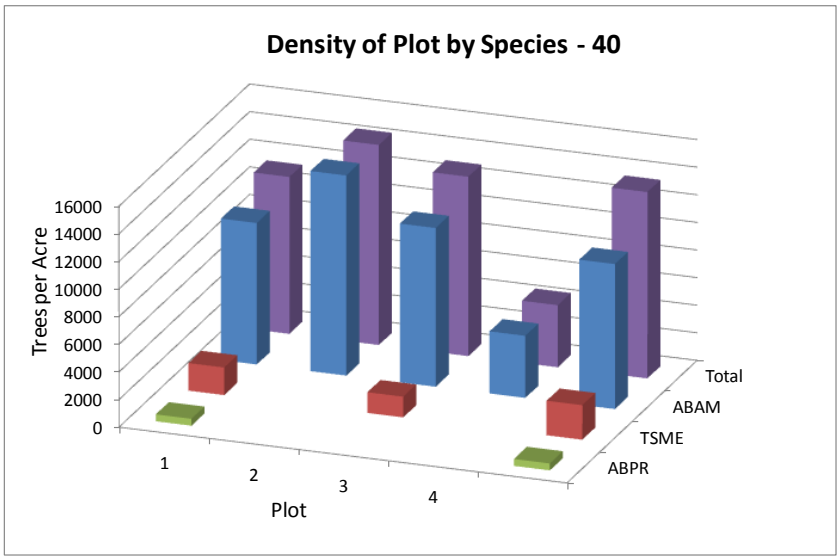

Density of Height by Plot - 29.4
Trees per Acre
3000
2500
2000
1500
1000
500
0
Total
0 - 2'
2 - 5'
5' - 10'
10' - 20'
>20'
Height Class
1
2
3
4
5
Plot

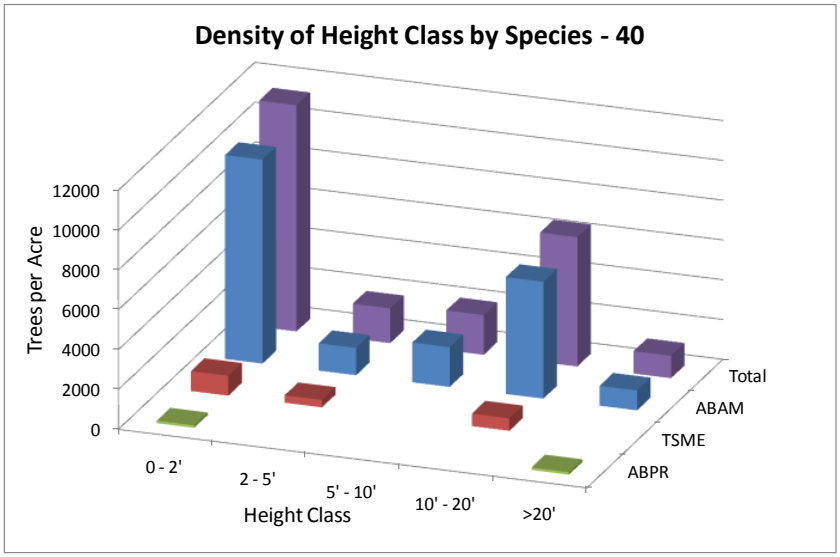

Density of Plot by Species - 29.4
Trees per Acre
3000
2500
2000
1500
1000
500
0
1
2
3
4
5
Plot
Total
TSHE
ABAM
PSME


Density of Height Class by Species - 29.4
Trees per Acre
1400
1200
1000
800
600
400
200
0
0 - 2'
2 - 5'
5' - 10'
10' - 20'
>20'
Height Class
Total
TSHE
ABAM
PSME

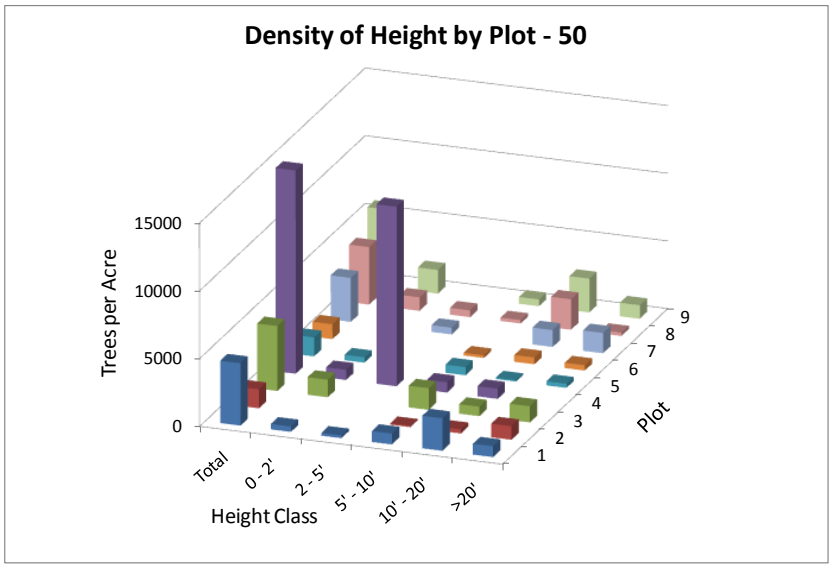
Unit 40

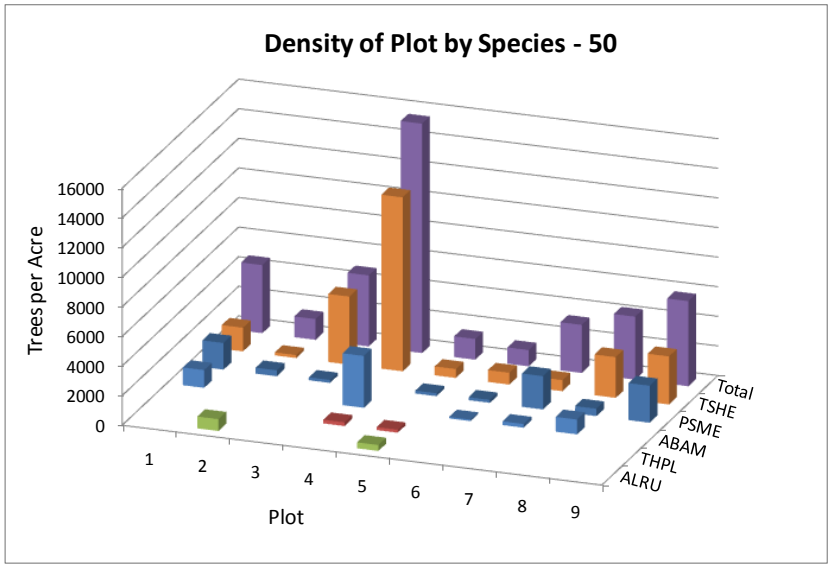

Density of Height by Plot - 40
Trees per Acre
15000
10000
5000
0
Total
0 - 2'
2 - 5'
5' - 10'
10' - 20'
Height Class
1
2
3
4
Plot

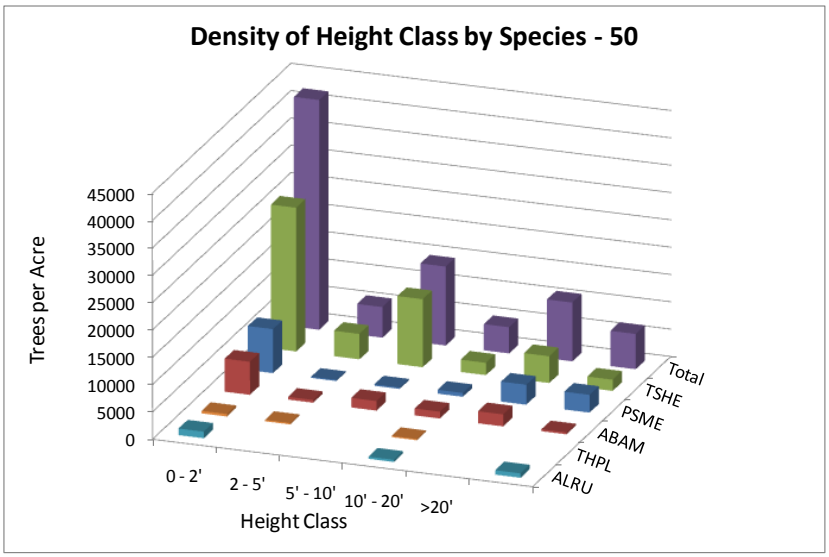

Density of Plot by Species - 40
Trees per Acre
16000
14000
12000
10000
8000
6000
4000
2000
0
1
2
3
4
Plot
Total
ABAM
TSME
ABPR


Density of Height Class by Species - 40
Trees per Acre
12000
10000
8000
6000
4000
2000
0
0 - 2'
2 - 5'
5' - 10'
10' - 20'
>20'
Height Class
Total
ABAM
TSME
ABPR

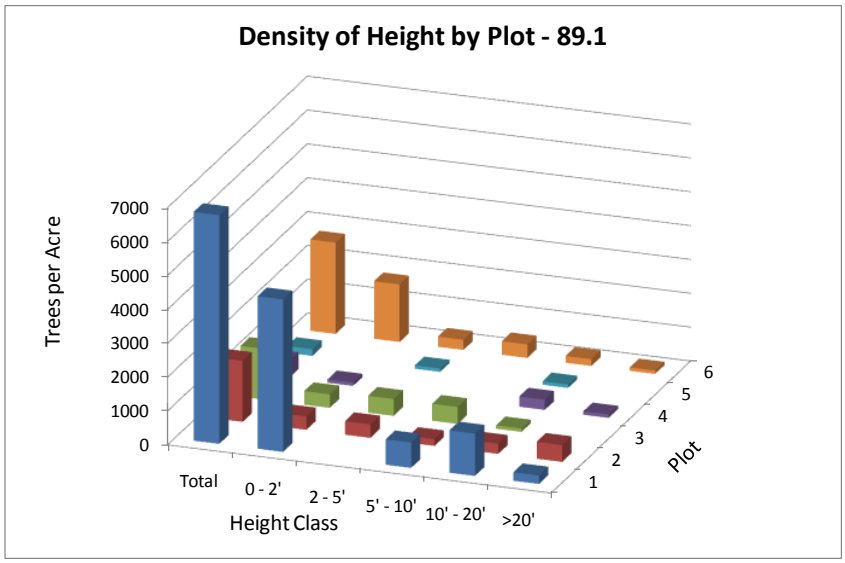
Unit 50

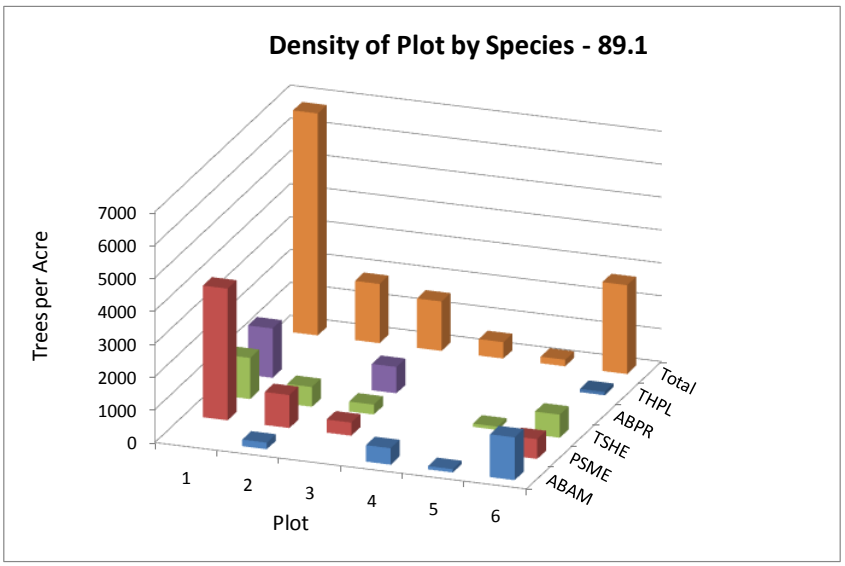

Density of Height by Plot - 50
Trees per Acre
15000
10000
5000
0
Total
0 - 2'
2 - 5'
5' - 10'
10' - 20'
>20'
Height Class
1
2
3
4
5
6
7
8
9
Plot

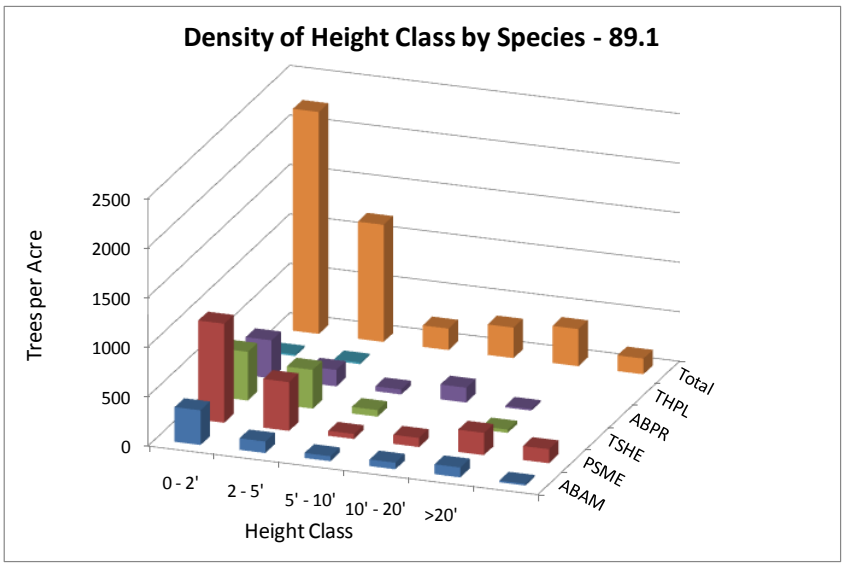

Density of Plot by Species - 50
Trees per Acre
16000
14000
12000
10000
8000
6000
4000
2000
0
1
2
3
4
5
6
7
8
9
Plot
Total
TSHE
PSME
ABAM
THPL
ALRU


Density of Height Class by Species - 50
Trees per Acre
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
0 - 2'
2 - 5'
5' - 10'
10' - 20'
>20'
Height Class
Total
TSHE
PSME
ABAM
THPL
ALRU

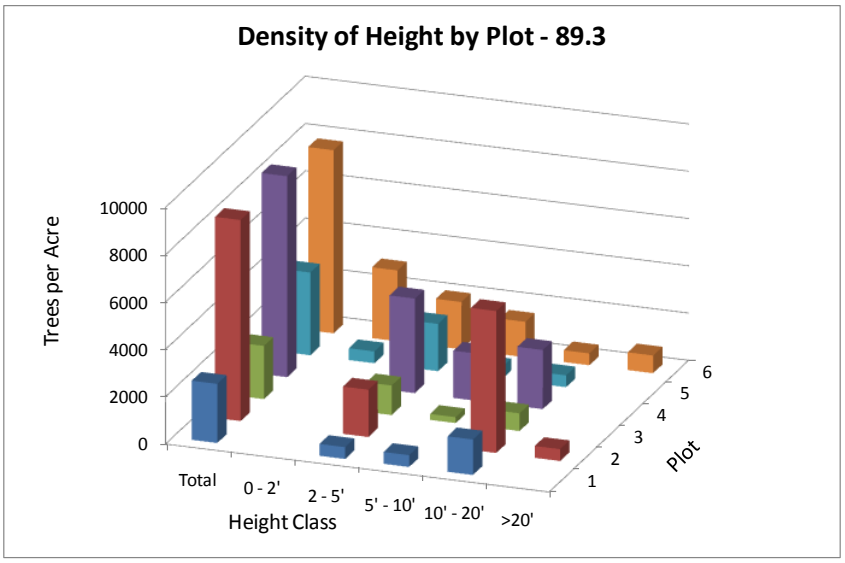
Unit 89.1

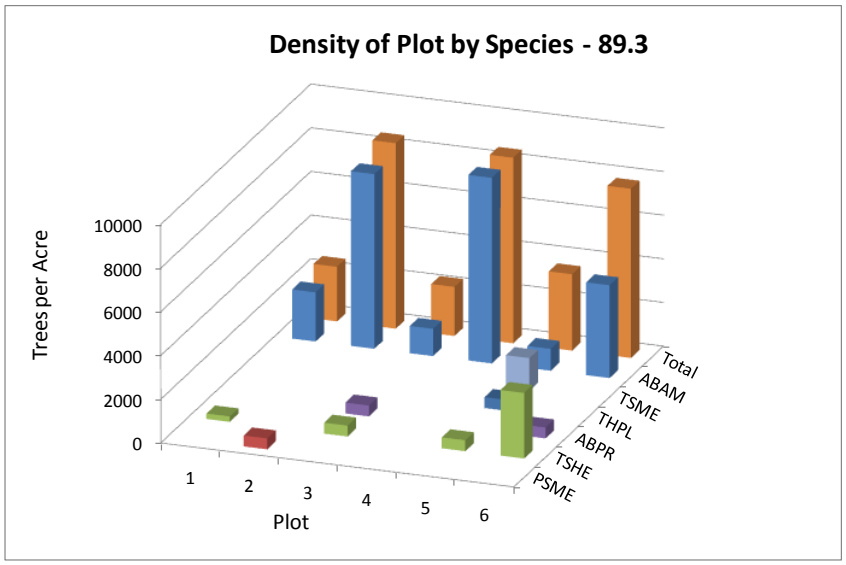

Density of Height by Plot - 89.1
Trees per Acre
7000
6000
5000
4000
3000
2000
1000
0
Total
0 - 2'
2 - 5'
5' - 10'
10' - 20'
>20'
Height Class
1
2
3
4
5
6
Plot

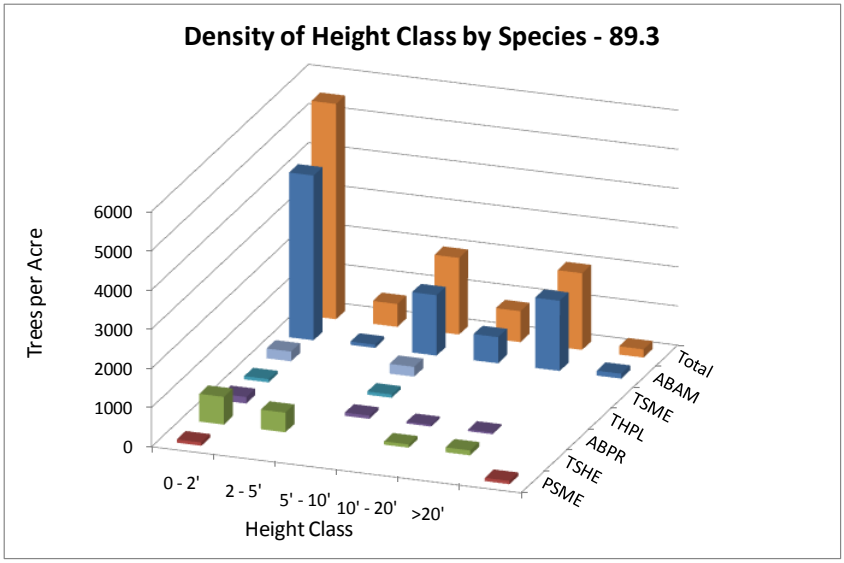

Density of Plot by Species - 89.1
Trees per Acre
7000
6000
5000
4000
3000
2000
1000
0
1
2
3
4
5
6
Plot
Total
THPL
ABPR
TSHE
PSME
ABAM


Density of Height Class by Species - 89.1
Trees per Acre
2500
2000
1500
1000
500
0
0 - 2'
2 - 5'
5' - 10'
10' - 20'
>20'
Height Class
Total
THPL
ABPR
TSHE
PSME
ABAM

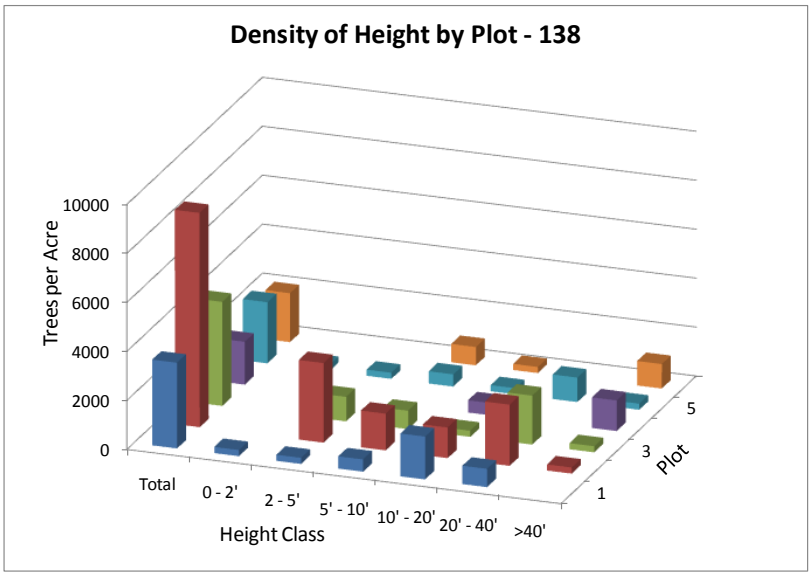
Unit 89.3

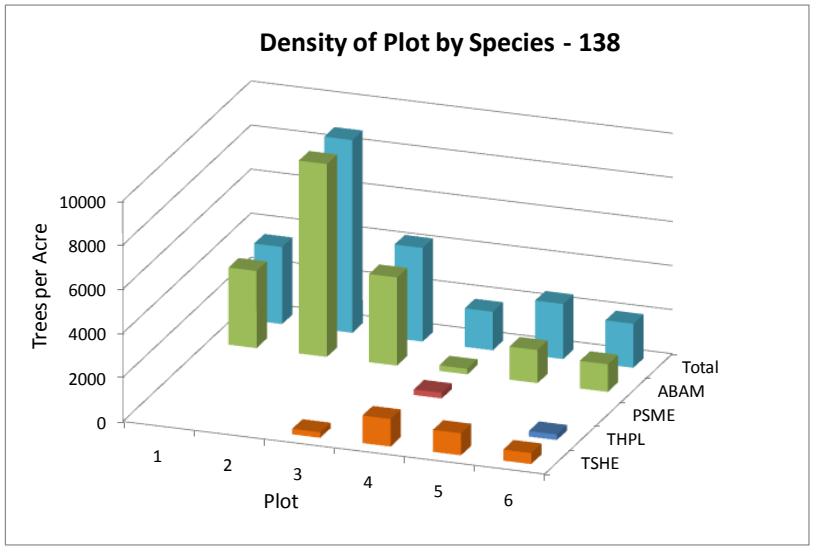

Density of Height by Plot - 89.3
Trees per Acre
10000
8000
6000
4000
2000
0
Total
0 - 2'
2 - 5'
5' - 10'
10' - 20'
>20'
Height Class
1
2
3
4
5
6
Plot

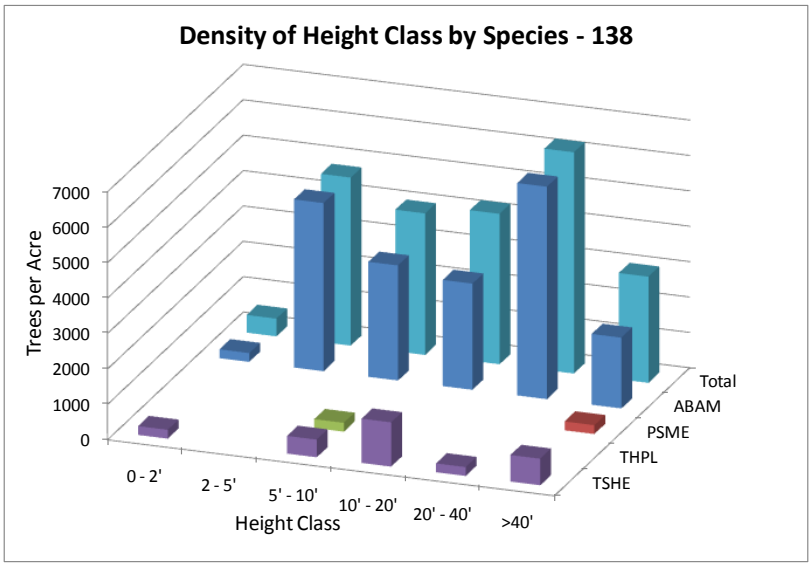

Density of Plot by Species - 89.3
Trees per Acre
10000
8000
6000
4000
2000
0
1
2
3
4
5
6
Plot
Total
ABAM
TSME
THPL
ABPR
TSHE
PSME


Density of Height Class by Species - 89.3
Trees per Acre
6000
5000
4000
3000
2000
1000
0
0 - 2'
2 - 5'
5' - 10'
10' - 20'
>20'
Height Class
Total
ABAM
TSME
THPL
ABPR
TSHE
PSME

Unit 138


Density of Height by Plot - 138
Trees per Acre
10000
8000
6000
4000
2000
0
Total
0 - 2'
2 - 5'
5' - 10'
10' - 20'
20' - 40'
>40'
Height Class
Plot
1
3
5


Density of Plot by Species - 138
Trees per Acre
10000
8000
6000
4000
2000
0
1
2
3
4
5
6
Plot
Total
ABAM
PSME
THPL
TSHE


Density of Height Class by Species - 138
Trees per Acre
7000
6000
5000
4000
3000
2000
1000
0
0 - 2'
2 - 5'
5' - 10'
10' - 20'
20' - 40'
>40'
Height Class
Total
ABAM
PSME
THPL
TSHE

Appendix B. SPU Protocol for Restoration Thinning Compliance Monitoring

Compliance monitoring for SPU acceptance and payment of restoration thinning units will involve inspection of a series of plots uniformly distributed over the entire unit. The consultant must familiarize himself with the Restoration Thinning Contract and Restoration Thinning Prescriptions before commencing compliance work.

Unit layout and plot location

SPU staff will identify unit boundaries and overlay appropriate compliance plot grid on restoration thinning compliance maps. Plots that fall into skip and gap areas shall be sampled to provide post thinning structural information. For units that contain skips and/or gaps, add a tally point midway between each plot. Record a status tally of skip, gap, or thin for each plot location and each tally location between plots. Record GPS data with a minimum of 25% of the plots, with a focus on georeferencing transects upon which plots are placed if satellite coverage is low.

Plot frequency and size

The plot overlay grid will be one plot for every 3 acres of thinning, with a minimum of 5 plots per unit or otherwise determined by SPU staff. Plot size will be 1/50th acre or adjusted to represent structural variability. The radius for a $1/50^{th}$ acre plot is 16.7 feet, horizontal distance. Skip and gap tally points will be collected at each plot and at points midway between plots with a minimum of 10 tally points per unit with skips and gaps. If a measure plot hits a skip or gap, then it will grade that skip/gap on a pass/fail rating based on skip/gap size and leave trees according to the specific prescription; an inventory plot will not be taken. Horizontal correction for slope will be necessary.

Definitions

Excess tree - A live tree whose species is selected to be cut which the restoration thinning contractor, contrary to the specifications, has left uncut, has not completely severed from the stump, has left as a hang-up tree, has left with a stump exceeding the specified maximum height, or has left live limbs on stump.

Deficient trees - Those trees cut of species selected to be cut which should have been left to maintain average spacing requirements, or trees not selected according to the prescriptions, or leave trees that are excessively damaged by the thinning operation.

Tree measurements

To gather residual stand information, each tree plot will be sampled in the electronic format created for field use or office entry. The following information shall be recorded:

- Species and dbh (1.0” classes) of leave trees
- Height and percent live crown of representative sample of leave trees (3-5 trees per plot representative of species and dbh class)
- Tree damage (refer to damage codes at the end of this protocol)
- Tree count of trees <4.5’ height by species

Compliance measurements
To document whether the thinning prescription was implemented correctly, the following information shall be recorded in the same electronic format as the tree measurements:

- Number of leave trees that should have been retained according to the prescription.
- Number of trees that were retained.
- Number of satisfactory leave trees retained.
- Number of *deficient* trees (uncorrectable work), including trees cut outside the diameter range or species preferences.
- Number of *excess* trees (correctable work).
- Tally of skip, gap, or thin on each plot and tally point throughout the unit
- Percentage of plot area that meets slash treatment specifications (lopping to within certain distance of ground surface)
- Percentage of unit area that meets slash treatment specifications (lopping and piling within a certain distance of road or old forest edge)

For units that have skips and/or gaps with no spacing collect tally points with a sample a grid of one tally point per acre; inspect the size of skips/gaps, as well as leave tree preferences, as prescribed.

Calculation of quality percentage
Upon completion for a unit, the compliance quality of thinning shall be calculated as follows:

$$1.00 - \left[\frac{\text{absolute value (No. of deficient trees - No. of excess trees)}}{\text{No. of leave trees that should have been left}} \right] \text{x } 100 = \text{Quality \%}$$

The quality % is calculated separately for each thinning unit and rounded to the nearest 0.1% for pay purposes. The City's inspection results will be used for determining payment to the restoration thinning contractors.

Additional compliance responsibilities
In addition to plot sampling within the thinning units, restoration thinning compliance responsibilities include:

- Ensuring that each unit is complete and within the unit boundaries
- Inspecting skip and gap installation as prescribed
- Ensuring slash treatment is complete to specifications, if prescribed
- Ensuring that stump heights throughout the unit meet contract specifications
- Inspecting road surface, ditch and bank cleanup on each unit as complete
- Ensuring that work sites are left free of garbage and debris
- Preventing hazardous materials spills by keeping spill kits on site and refueling SPU supplied pads

- Ensuring that hazmat spills are reported and cleaned up correctly
- Ensure that contractors carry the appropriate fire tools and conduct fire watch
- Checking that contractors bring the SPU supplied sanican to each work site

Insect, Disease, and Damage Codes

Source: PNW-FIA IDB Code Definitions

Required codes recorded with tree records

01	Bark beetles
10	Defoliators
20	Other insects
30	Mistletoe
40	Rusts, cankers, bole rot
50	Needle casts
60	Root diseases
70	Animal damage
80	Weather related damage
90	Physical damage
99	Unknown; or dead

Optional codes recorded with tree records instead of required codes

01	General/other bark beetles
02	Mountain pine beetle (All Pinus spp.)
03	Douglas-fir beetle (PSME)
04	Spruce beetle (Picea spp.)
05	Western pine beetle (PIPO)
06	Pine engraver (All Pinus spp.)
07	Fir engraver (Abies spp.)
08	Silver fir beetle (ABAM)
09	Red turpentine beetle (All Pinus spp.)
10	General/other defoliators
11	Western blackheaded budworm
12	Pine butterfly
13	Douglas fir tussock moth
14	Larch casebearer
15	Western spruce/Modoc budworm
16	Western hemlock looper
17	Sawflies
18	Needle and sheath miners
19	Gypsy moth
20	General/other insects
21	Shoot moths
22	Weevils
23	Wood borers
24	Balsam woolly adelgid
30	Dwarf mistletoe
31	True mistletoe (hardwoods)
36	White pine blister rust
40	General/other stem-branch cankers
41	Western gall rust
42	Comandra blister rust
43	Stalactiform rust
44	Atropellis canker
45	Cytospora/Phomopsis
46	General/other stem decays
47	Red ring rot
48	Rust red stringy rot
49	Brown cubical butt rot
55	General/other foliar pathogens
56	Rhabdocline needle cast
57	Elytroderma needle cast
58	Broom rusts (Only Abies, Picea)
59	Swiss needle cast
60	General/other root diseases
61	Annosus root disease
62	Armillaria root disease
63	Black stain root disease
65	Laminated root rot
66	Port-Orford-cedar root disease

70	Animal-General/ unknown
71	Mountain beaver
72	Livestock
73	Deer or elk
74	Porcupines
75	Pocket gophers, squirrels, mice, voles, rabbits, hares
76	Beaver
77	Bear
78	Human (not logging)
80	Weather-General/Unknown
81	Windthrow or wind breakage
82	Snow/ice bending or breakage
83	Frost damage on shoots
84	Winter desiccation
85	Drought/heat moisture deficiency
86	Sun scald
87	Lightning strike
90	Physical-General/unknown
91	Logging
92	Fire: basal scars or heat
93	Improper planting technique
94	Air pollution or other chemicals
95	FIA: Broken/Missing top/ dead top
96	FIA: Forked top
97	Crooks/Sweep
98	Checks and bole cracks